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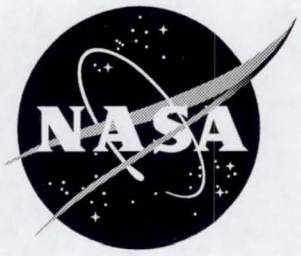

Structures and Materials Experimental Facilities and Capabilities Catalog

Compiled by:

Lucas G. Horta
Langley Research Center, Hampton, Virginia

Jeanette D. Kurtz-Husch
NCI Information Systems, Inc., Hampton, Virginia

June 2000

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National Aeronautics and
Space Administration

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Hampton, Virginia 23681-2199

June 2000

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Introduction

The NASA Center of Excellence for Structures and Materials at Langley Research Center is responsible for conducting research and developing useable technology in the areas of advanced materials and processing technologies, durability, damage tolerance, structural concepts, advanced sensors, intelligent systems, aircraft ground operations, reliability, prediction tools, performance validation, aeroelastic response, and structural dynamics behavior for aerospace vehicles. Supporting such a variety of research activities is a complementary set of facilities and capabilities documented in this report. Because of the volume of information, the information collected was restricted in most cases to one page. Specific questions from potential customers or partners should be directed to the points of contacts provided with the various capabilities. Grouping of the equipment is by location as opposed to function. Geographical information of the various buildings housing the equipment is also provided. Since this is the first time that such an inventory is ever collected at Langley it is by no means complete. It is estimated that over 90 % of the equipment capabilities at hand are included but data is still being collected and will be reported in the future.

NASA Langley Research Center Map

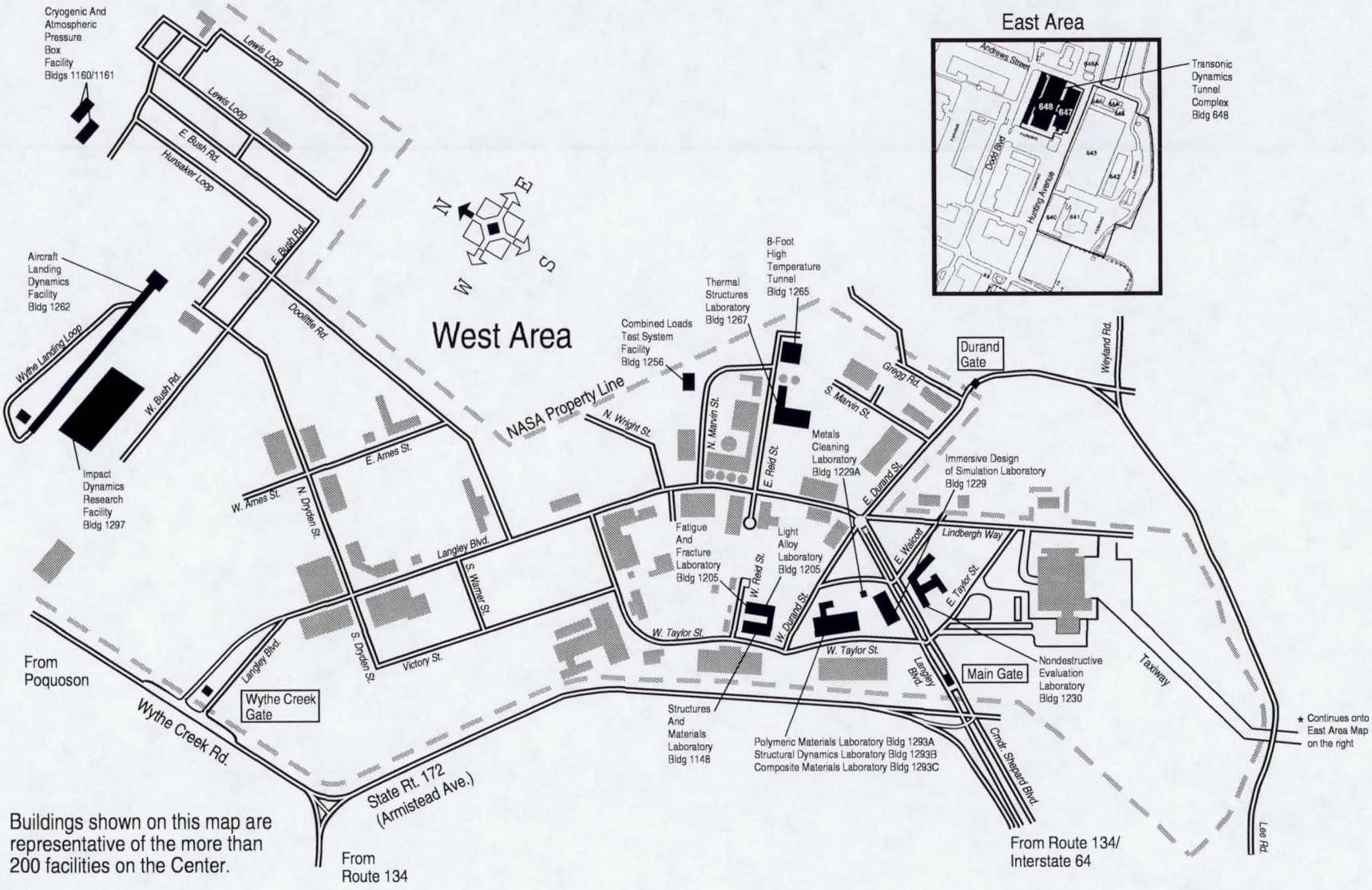


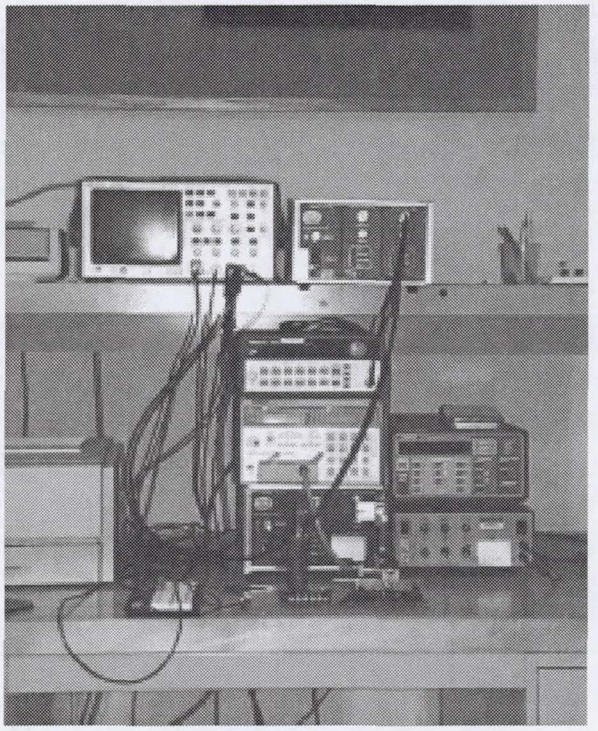
Table of Contents

Structures And Materials Laboratory (Bldg 1148)

Ferroelectric Hysteresis Looper

Purpose:

- To characterize the performance of ferroelectric materials by analyzing material's hysteresis behavior



Primary Capabilities:

- Measure displacement, coercive field and polarization of ferroelectric materials

Special/Unique Capability:

- Testing of ferroelectric materials

Equipment/Instrumentation:

- ±750 V maximum electrical field
- Interfaced with oscilloscope for measurement of coercive field and polarization
- Frequency: 100 Hz - 100 kHz
- Resolution: 10 Hz

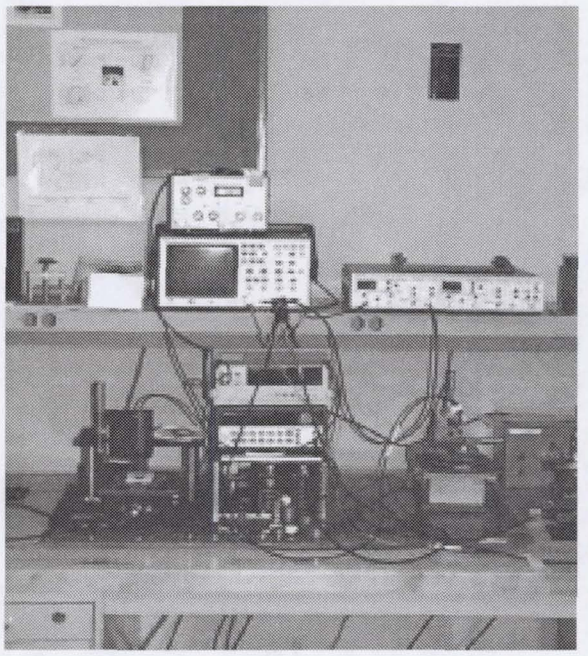
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Fiber Optic Displacement Measurement System

Purpose:

- To measure the small displacements associated with piezoelectric and electrostrictive materials



Primary Capabilities:

- Measurement of small displacements

Special/Unique Capability:

- Resolution to 0.1 micron

Equipment/Instrumentation:

- Resolution to 0.1 micron
- ±750 V maximum electrical field
- Interfaced with oscilloscope for measurement of displacement and displacement hysteresis
- Ranges:
  - 125 μm sensor ±0.0025″ and ±0.0035″
  - 200 μm sensor ±0.0035″ and ±0.0075″
  - 300 μm sensor ±0.006″ and ±0.009″
- Frequency: 100 μHz - 100 kHz, with 10 μHz resolution

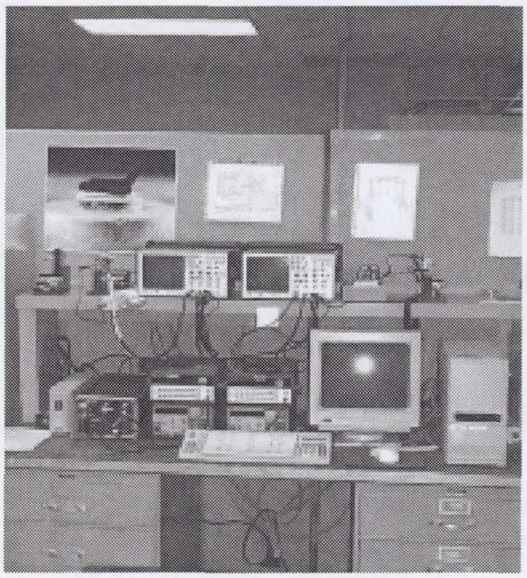
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Piezoelectric Fatigue Systems

Purpose:

- To conduct fatigue tests on piezoelectric-material-based actuators



Primary Capabilities:

- Long-term fatigue test

Special/Unique Capabilities:

- Unattended testability
- Automatic data storage

Equipment/Instrumentation:

- Room temperature fatigue measurements
- Ranges:
  - 200 μm sensor ±0.0035″ and ±0.0075″
  - 300 μm sensor ±0.006″ and ±0.009″
- Frequency: 100 μHz - 100 kHz, with 10 μHz resolution
- Stroke measurements corresponding to a voltage within 0 - 1500 V
- Computer controlled operation

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Impedance Analyzer

Purpose:

- To determine the resonance behavior and electromechanical coupling coefficients of piezoelectric materials

Primary Capability:

- Characterize the performance of piezoelectric materials

Special/Unique Capability:

- 40 Hz to 100 MHz operation

Equipment/Instrumentation:

- 40 Hz to 100 MHz operation, adjustable frequency range
- Computer storage of data
- Voltage: ± 1100 V
- Current: ± 100 mA

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Inductance/Capacitance/Resistance System

Purpose:

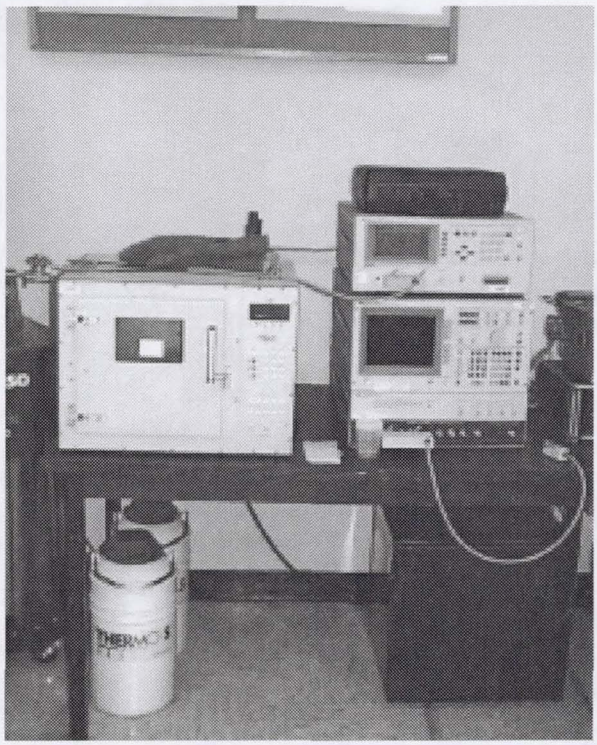
- Characterize the diectric properties of piezoelectric materials at selected frequencies

Primary Capability:

- To measure dielectric properties of materials

Special/Unique Capability:

- Temperature effects from a cryogenic point to several hundred degrees



Equipment/Instrumentation:

- Frequency: 100 μHz - 100 kHz, with 10 μHz resolution
- Amplitude: 0 - 1500 V
- Temperature: -84°C (-120°F) to 315 °C (600°F), with resolution: 0.02°C (0.04°F)
- Impedance: 0.01 mΩ - 100 MΩ
- Capacitance: 0.01 fF - 10.0 F
- Inductance: 0.01 nH - 100 kH

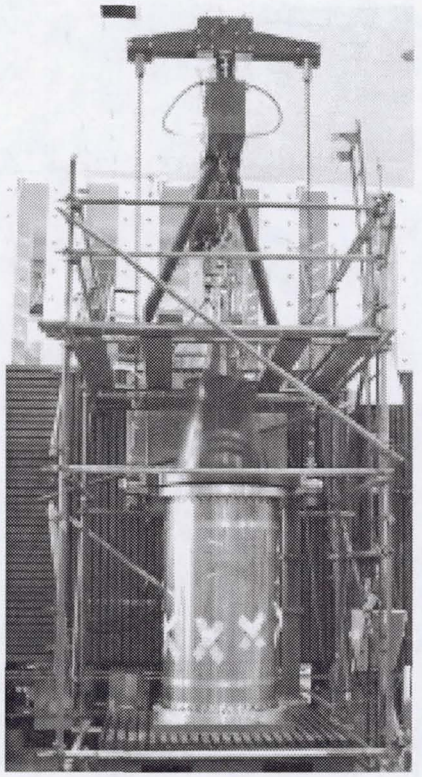
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Bending, Torsion and Shear Loading Test Machine

Purpose:

- To experimentally investigate cylindrical structural response and damage initiation and crack growth when subjected to combined mechanical loading conditions.



Primary Capabilities:

- Bending moment load – 2,500,000 in-lbs.
- Torsional load – 2,800,000 in-lbs.
- Transverse shear – 100,000 lbs.
- Specimen diameter – 12,18,24,30, 36 in.
- Specimen length – 66-in. maximum

Special/Unique Capability:

- Actively controlled profiles for combined loading conditions.

Equipment/Instrumentation:

- Data Acquisition system - 512 channels (typical, 320 additional channels available) with real-time plots and engineering units readout

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Harold G. Bush (757) 864-3099 or Branch Head: Dr. Damodar R. Ambur (757) 864-3174

Film Creep Test Machine

Purpose:

- To measure the creep properties of polymeric films for spacecraft applications

Primary Capability:

- Measure creep properties of thin films with high accuracy

Special/Unique Capabilities:

- Capability to test both flat films and pressurized cylindrical specimens
- Temperature range –140°C (-220°F) to 120°C
- (250°F)
- Can test up to four (4) specimens at one time

Equipment/Instrumentation:

- Chamber: 4 ft i.d. x 5 ft L
- Specimen dimensions 3" W (or 3" dia.) x 27" L
- Fixture holds four (4) specimen heating/cooling jackets
- Creep measured photographically with two digital cameras per specimen
- Automated data acquisition and image processing

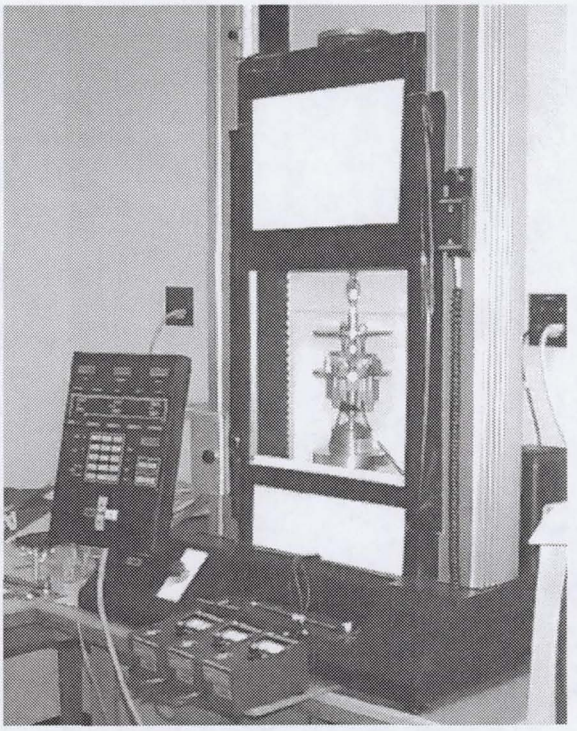
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Glen C. King (757) 864-4123 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

1-Kip Instron Load Frame

Purpose:

- Quasi-static load cycling of joints and mechanisms for precision deployable structures.



Primary Capabilities:

- 1 Kip capacity load-frame
- Variable speed crosshead; operate from load-frame controller or remote Macintosh data system in displacement-control mode (no load-control mode)
- Crosshead speed range: .0004 – 40-in/min
- Max. specimen length 36-in

Special/Unique Capability:

- GPIB serial connection between load frame controller and Mac data system. LabView software on Mac data system that includes an Instron controller emulator for remote experiment control

Equipment/Instrumentation:

- High-resolution, 200-lb-capacity, tension-compression load cell
- Four-channel serial data connection to Mac data system
- Multiple serial connection lines for load and displacement data
- Mechanical chuck for specimen installation
- Numerous specimen installation and instrumentation fixtures available

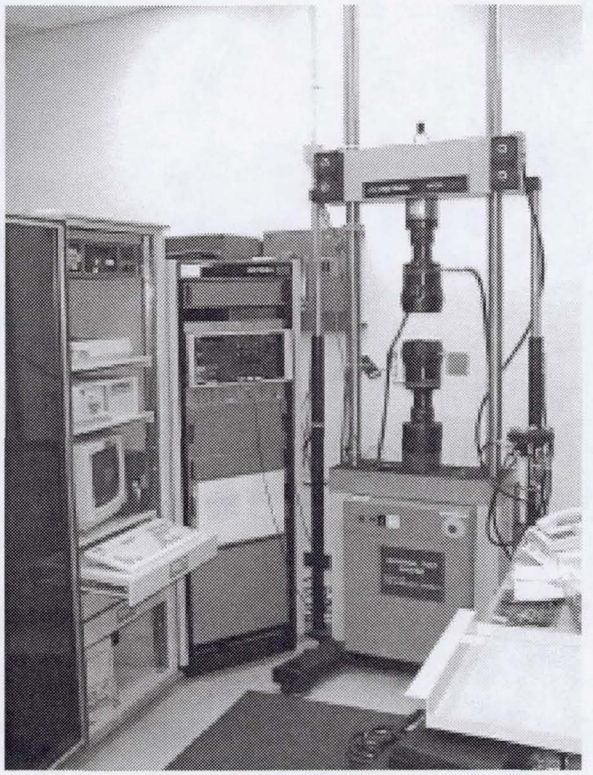
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Mark S. Lake (757) 864-3114 or Branch Head: Dr. Damodar R. Ambur (757) 864-3174

1-Kip Cyclic-Load Universal Test Machine

Purpose:

- To measure the mechanical properties of materials and to conduct fatigue tests



Primary Capabilities:

- Tension and compression measurements of materials
- Cyclic load capability

Special/Unique Capability:

- Rapid cycle rates for fatigue testing, up to 100 Hz

Equipment/Instrumentation:

- Load frame 1000 lb
- Tensile, compressive, and cyclic tests modes
- Load or rate control
- Special grips for film testing

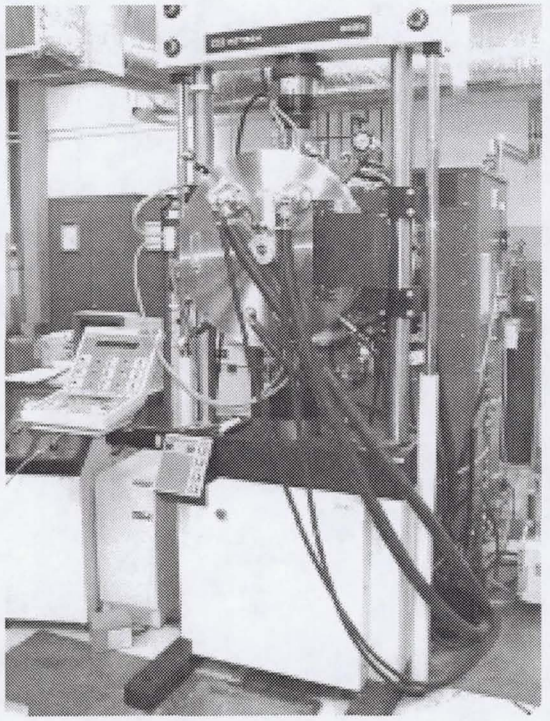
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

20-Kip High-Temperature Universal Test Machine

Purpose:

- To measure the mechanical properties of materials at elevated temperatures



Primary Capabilities:

- Tension and compression measurements of materials at elevated temperatures
- Cyclic load capability

Special/Unique Capabilities:

- Temperatures to 1650°C (3000°F)
- Inert gas (1 atm.) or vacuum operation

Equipment/Instrumentation:

- Test temperatures to 1650°C (3000°F)
- Hot zone: 4-in. dia. x 3-in. or 8-in. H.
- Vacuum or inert gas environment (1 atm.)
- Load frame 20,000 lb.
- Tensile, compressive, and cyclic test modes
- Load or rate control
- Strain rate capability down to $4x10^{-5}$ in./hr
- Heated compression platens
- High-temperature rod extensometer to 1600°C (2900°F)

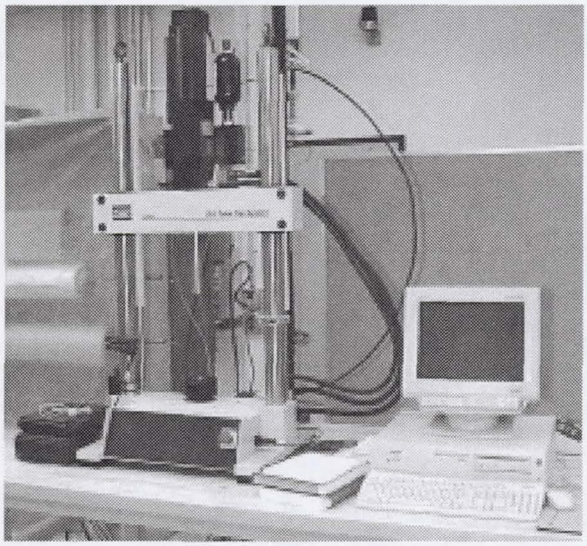
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

20-Kip Low-Strain-Rate Universal Test Machine

Purpose:

- To measure the mechanical properties of materials, specifically carbon-carbon composites and other ceramic-based materials



Primary Capabilities:

- Tension and compression measurements of materials
- Cyclic load capability

Special/Unique Capability:

- Ultra-low-strain rate capability, $4x10^{-5}$ in./hr

Equipment/Instrumentation:

- Load frame 20,000 lb.
- Tensile, compressive, and cyclic test modes
- Load or rate control

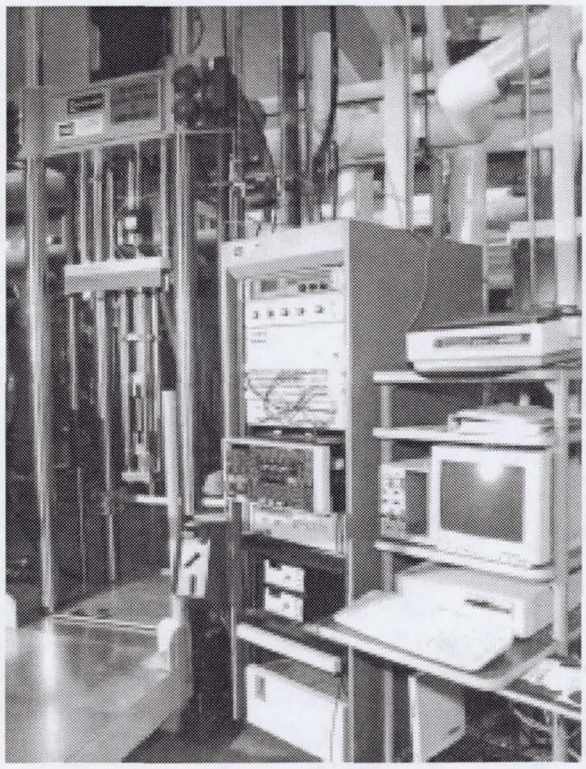
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

100-Kip Inverted Test Stand

Purpose:

- To experimentally determine mechanical properties of materials under tensile or compressive loading.



Primary Capability:

- Test for mechanical properties of materials using ASTM standards. Test types include tension, compression, fracture toughness, fatigue.

Special/Unique Capability:

- Two cryogenic dewars to enable testing at LN_2 (-169°C) or LHe (-269°C) temperatures.

Equipment/Instrumentation:

- Load capacity - 100,000 lb
- Crosshead speed - 10^{-3} to 10^{2} in/min
- Cyclic frequency – 50 Hz
- Stroke – 6-in
- Dedicated computer–based controller for fatigue/fracture testing.

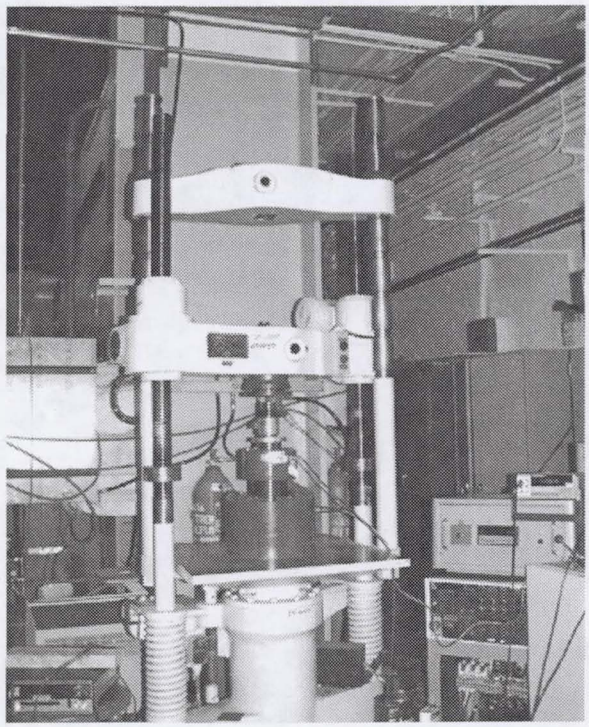
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Robert A. Hafley (757) 864-8078 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

100-Kip Tinus-Olsen Test Machine

Purpose:

- To experimentally determine structural response of small to medium size test specimens under mechanical loading



Primary Capabilities:

- Mechanical loading of specimens.
- Typical test types include compression, tension, buckling/crippling, damage propagation, and multi-point flexure
- 100,000 pound load capacity, tension and compression
- Maximum specimen height: 3-ft.
- Maximum specimen width: tension, 30-in.; compression 9-inches

Special/Unique Capabilities:

- Leveling platen for maintaining proper load introduction
- Larger compression specimens, up to 30 inches wide, may be tested if larger loading platens are provided
- Elevated temperature environment available

Equipment/Instrumentation:

- Mechanical grips
- Data Acquisition system - 512 channels (typical, 320 additional channels available) with real-time plots and engineering units readout

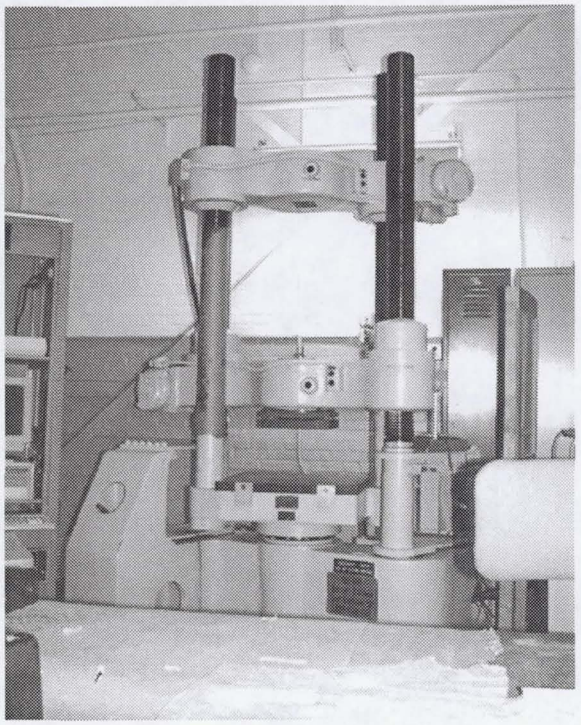
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Branch Head: Dr. Damodar R. Ambur (757) 864-3174

120-Kip Baldwin-Tate Test Machine and 120-Kip Southwark-Emery Test Machine

Purpose:

- To experimentally determine structural response of small to medium size test specimens under mechanical loading.



Primary Capabilities:

- Mechanical loading of specimens.
- Typical test types include compression, tension, buckling/crippling, damage propagation, and multi-point flexure
- 120,000 pound load capacity, tension and compression
- Maximum specimen height: 3.5-feet
- Maximum specimen width: 22-inches on a side

Special/Unique Capabilities:

- Leveling platen for maintaining proper load introduction
- Elevated temperature environment available

Equipment/Instrumentation:

- Mechanical grips
- Data Acquisition system - 512 channels (typical, 320 additional channels available) with real-time plots and engineering units readout

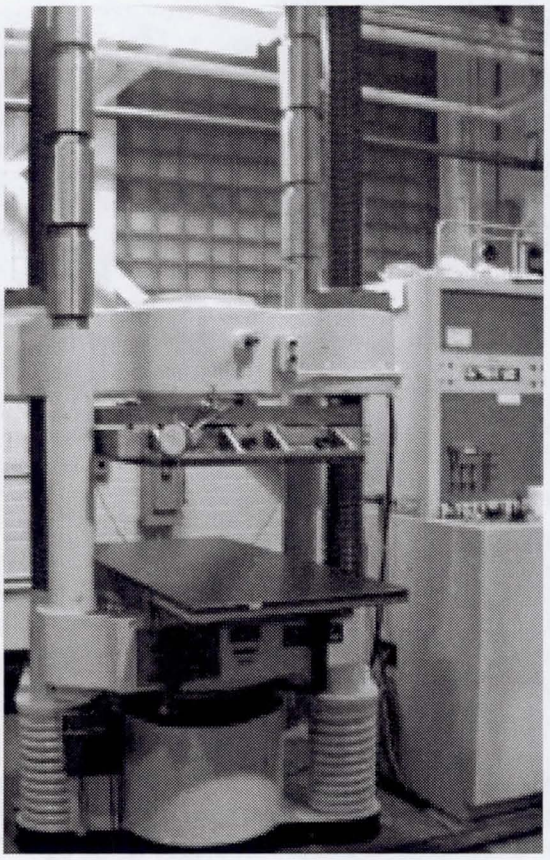
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Branch Head: Dr. Damodar R. Ambur (757) 864-3174

300-Kip Southwark-Emery Test Machine

Purpose:

- To experimentally determine the structural response of moderate size test specimens subjected to tensile or compressive loading.



Primary Capabilities:

- Load specimens to failure to evaluate the behavior of specimens including buckling and postbuckling response, failure mechanism, thermal effects, the effect of damage and damage propagation.
- 300,000 lb load capacity
- Maximum specimen dimension, including fixturing, is 29-inches wide and 3-feet tall

Special/Unique Capabilities:

- Leveling platen for maintaining proper load introduction
- Elevated temperature environment available

Equipment/Instrumentation:

- Data acquisition system recording up to 512 channels of data (typical, 320 additional channels available) with real-time plots and engineering units readout

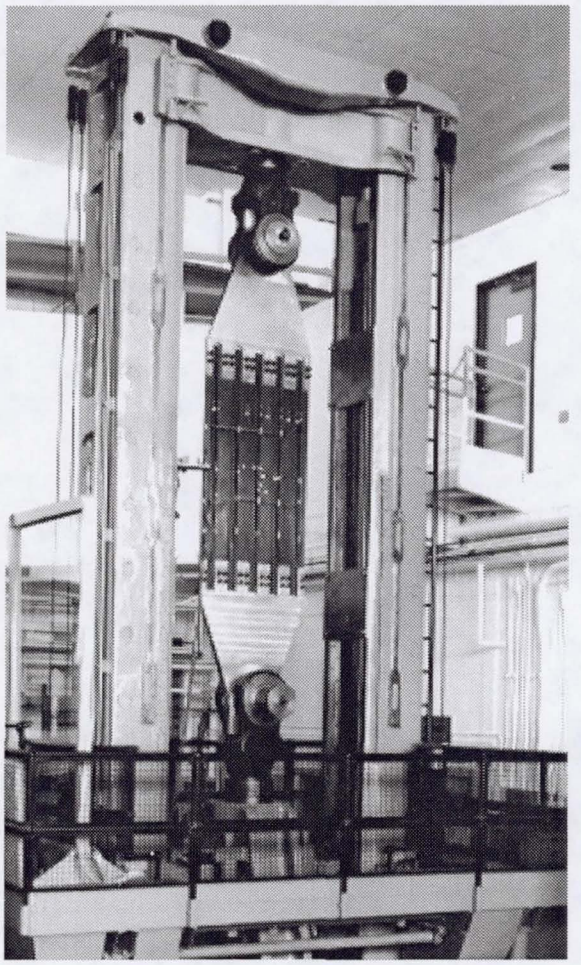
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Branch Head: Dr. Damodar R. Ambur. (757) 864-3174

One Million Pound Southwark-Emery Test Machine

Purpose:

- To experimentally determine the structural response of large and/or heavily loaded test specimens subjected to tensile or compressive loading



Primary Capabilities:

- Load specimens to failure to evaluate the behavior of large specimens including buckling and postbuckling response, failure mechanism in tension or compression, joint behavior, the effect of damage and damage propagation.
- 1,000,000 lb load capacity in tension or compression
- Maximum specimen width is 5-feet and maximum specimen height (including fixturing) is 12-feet
- Cylinders up to 5-feet in diameter

Equipment/Instrumentation:

- Numerous support fixtures available
- Data acquisition system recording up to 512 channels of data (typical, 320 additional channels available) with
- real-time plots and engineering units readout

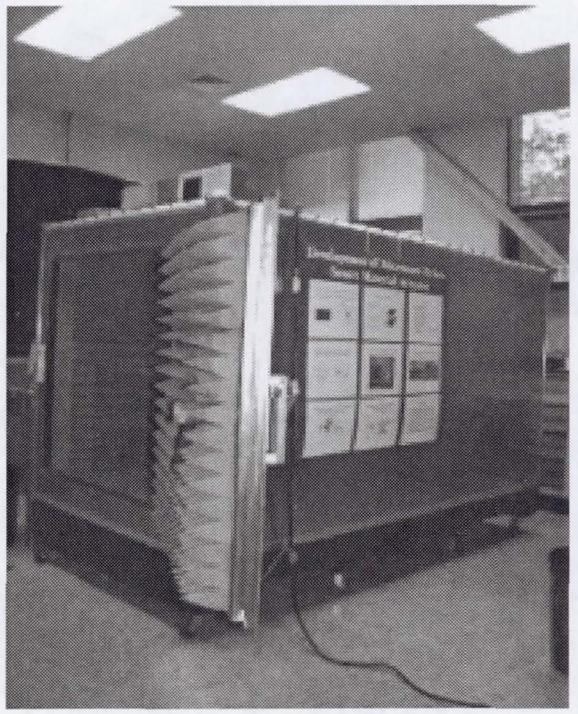
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Branch Head: Dr. Damodar R. Ambur (757) 864-3174

Anechoic Chamber & Microwave Generator

Purpose:

- To dampen microwave reflections in studies on the remote actuation of piezoelectric materials with microwave energy



Primary Capabilities:

- Enable the exploration and development of remotely activated (i.e., wire-less) piezoelectric actuators

Special/Unique Capabilities:

- Microwave coupling test of rectennas
- Test-beds for dielectric, inductive, and capacitive coupling effects of smart materials
- Monitoring variable rf field intensity

Equipment/Instrumentation:

- Interior dimensions 2 ft x 2 ft x 4 ft
- Exterior dimensions 5 ft x 5 ft x 8 ft
- Bandwidth: 2 ~ 28 GHz
- Input power up to 20 Watts with TWT amplifier

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

High-Temperature Specimen Furnaces

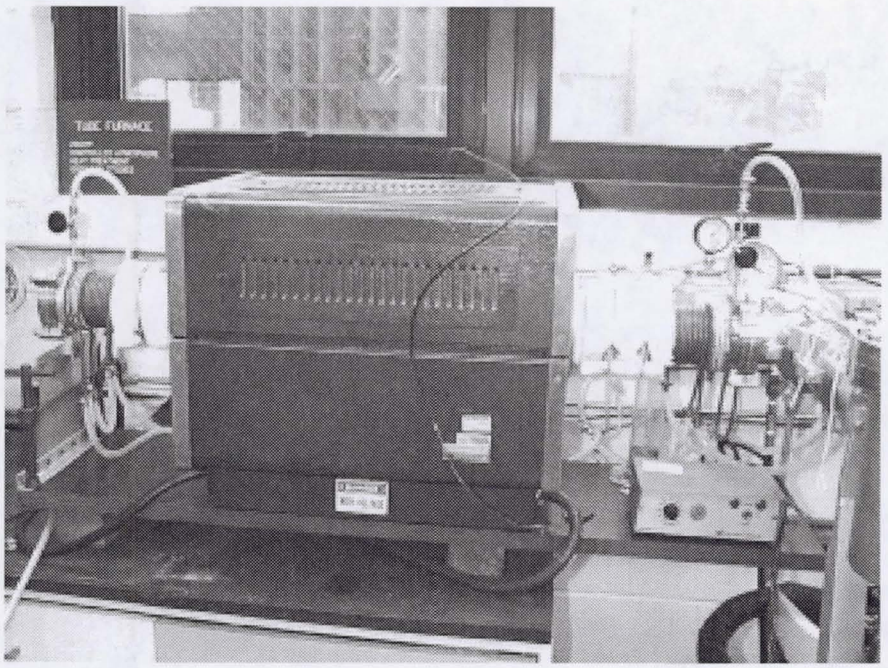
Purpose:
- Specimen heat treatment; oxidation studies; controlled environment thermal testing; processing of materials

Primary Capabilities:
- General purpose use

Special/Unique Capabilities:
- Temperatures to 1700°C (3100°F)
- Five furnaces of various types and geometries

Equipment/Instrumentation:
- Vacuum, inert gas, or air environments
- Geometries: vertical clam shell; horizontal or vertical tube; box
- Hot zones: 2" to 12"

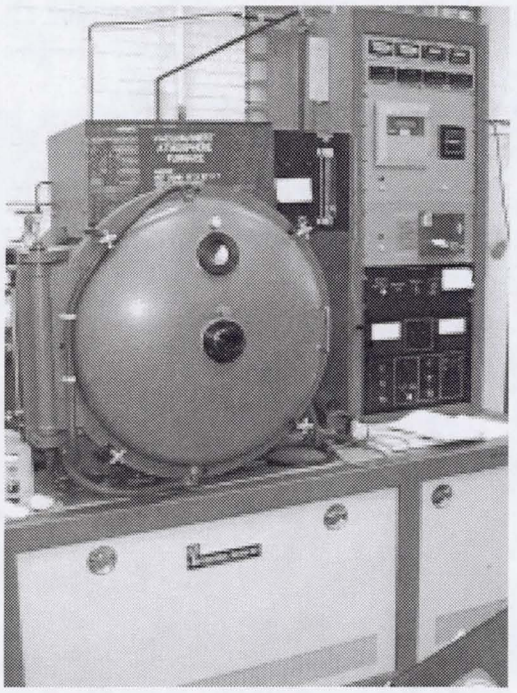
Point of Contact:
- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



High-Temperature Heat Treatment Furnace

Purpose:

- To heat treat materials to very high temperatures (e.g., for graphitizing carbon, applying high-temperature coatings, thermal stabilization of carbon fibers and fabric, etc.)



Primary Capabilities:

- 2700°C (4900°F) temperature

Special/Unique Capabilities:

- Temperature to 2700°C (4900°F)
- Vacuum or inert gas operation

Equipment/Instrumentation:

- Vacuum or inert gas (Ar, N_2, He) operation
- Pressure 50 microns to 1 atm.
- Temperature to 2400°C (4350°F) in Ar, to 2700°C (4900°F) in He
- Hot zone 11" W. x 12" D. x 6" H.
- Cold-wall furnace

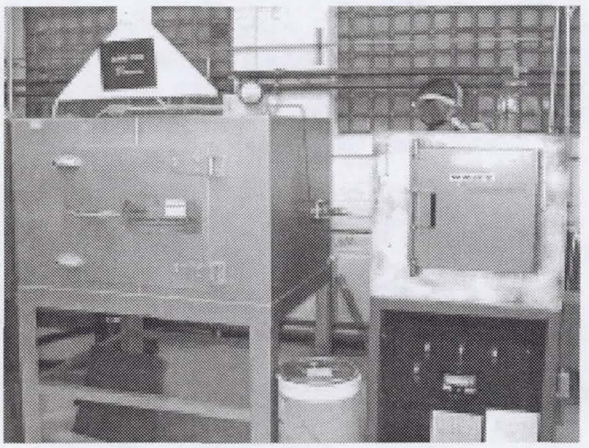
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Air-Circulation Ovens

Purpose:

- To cure resins or resin-impregnated carbon-carbon composites



Primary Capabilities:

- Forced air circulation ovens for materials processing

Special/Unique Capability:

- Two ovens: one to 590°C (1100°F), and one to 700°C (1300°F)

Equipment/Instrumentation:

- Programmable temperature control
- Temperature capability to 590°C (1100°F) and to 700°C (1300°F)
- Forced circulation
- Chambers 20" W x 20" D. x 20" H
- Can be inerted if desired

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Controlled Atmosphere Furnaces

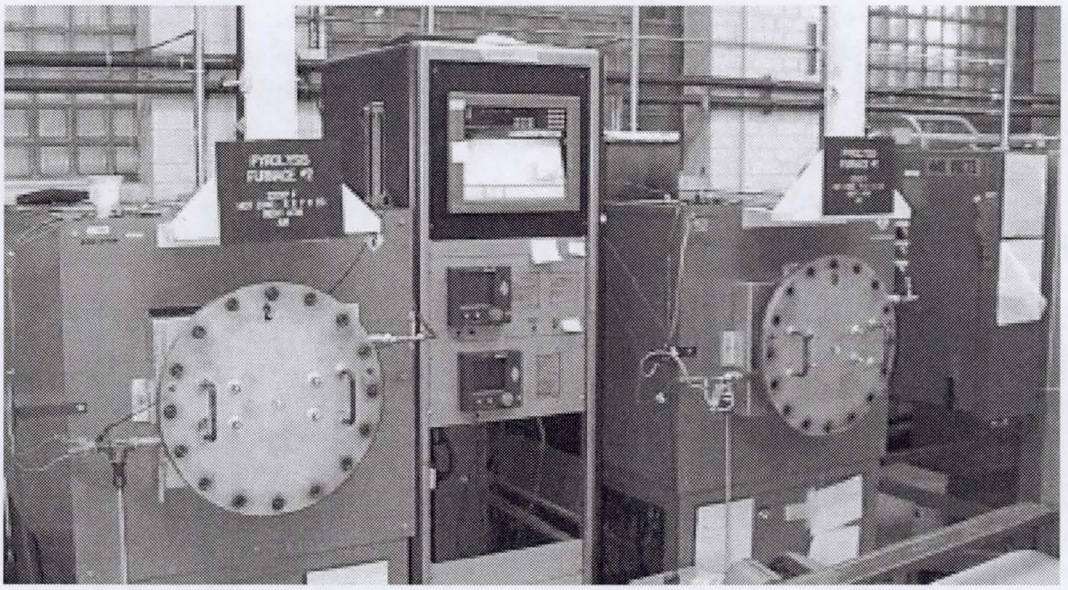
Purpose:
- To carbonize (pyrolyze) organic-matrix composites for the fabrication of carbon-carbon composites

Primary Capabilities:
- Inert gas operation
- Temperatures to 1100°C (2000°F)

Special/Unique Capabilities:
- Inert gas operation; operable in air or other controlled gas compositions if desired
- Two identical furnace systems

Equipment/Instrumentation:
- Programmable temperature control
- Temperature capability to 1100°C (2000°F)
- Inert gas operation in N_2 (typical)
- 1 atmosphere operation
- Chamber 11" W x 20" D x 7" H

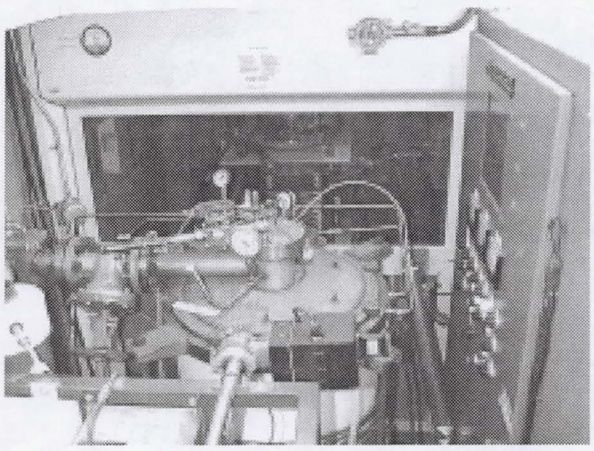
Point of Contact:
- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



Chemical Vapor Infiltration (CVI)/Chemical Vapor Deposition (CVD) Reactor System

Purpose:

- Infiltration of porous materials; deposition of coatings on carbon-carbon composites



Primary Capabilities:

- Densification of carbon-carbon composite materials; infiltration of carbon-carbon composites with a second phase; coating deposition on carbon-carbon composites

Special/Unique Capabilities:

- Temperatures to 1450°C (2640°F)
- Interchangeable reactor sections of different sizes

Equipment/Instrumentation:

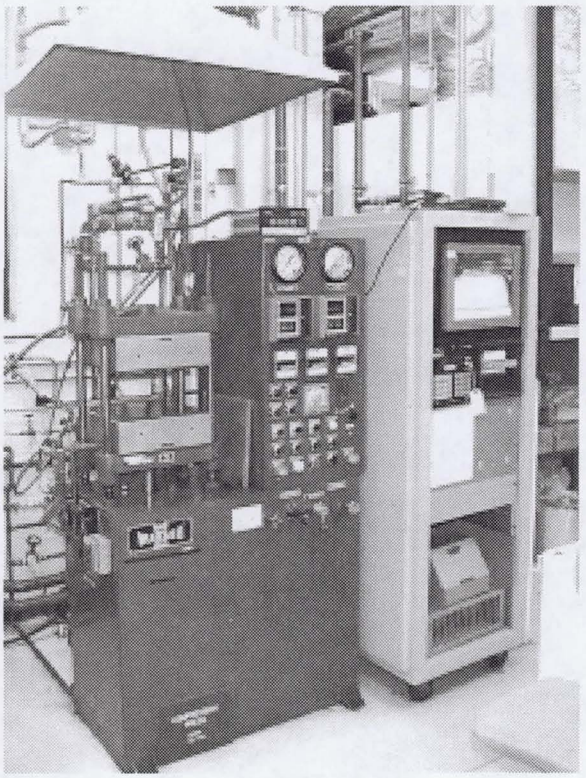
- Inductively heated; temperatures to 1450°C (2640°F)
- Gas handling manifold and scrubber system for halogens and acid gases
- Operating pressure 80 to 1000 mm Hg
- Maximum working volume: 20" dia. x 23" H

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Heated-Platen Compression Press

Purpose:
- To compression mold composite laminates



Primary Capabilities:
- Pressure and temperature control for compression molding of composite materials

Special/Unique Capability:
- 425°C (800°F) capability

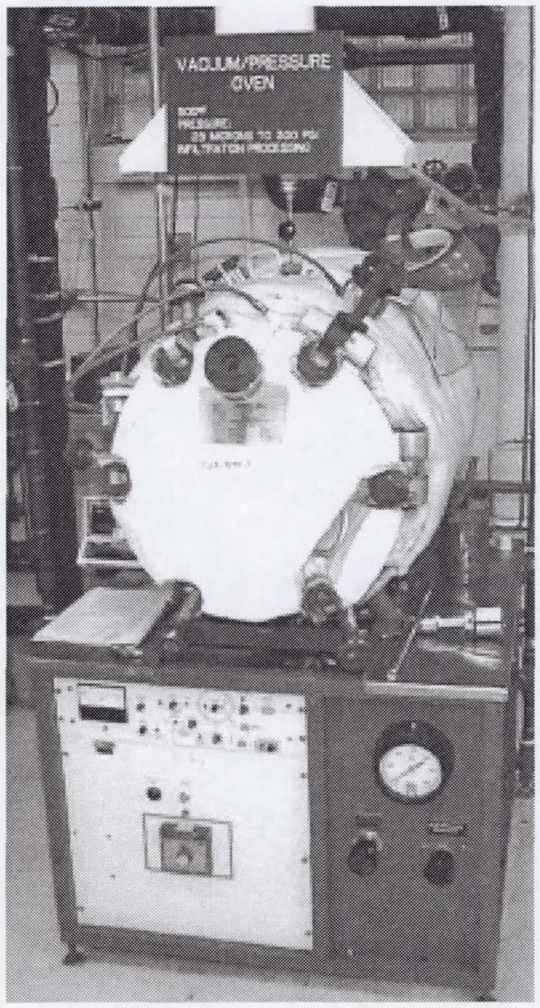
Equipment/Instrumentation:
- Programmable pressure and temperature control
- Temperature capability to 425°C (800°F)
- 12" x 12" platens
- 25-ton load capability
- Hydraulic operation

Point of Contact:
- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Vacuum/Pressure Impregnator

Purpose:

- To impregnate porous materials with resins or other carbonaceous liquids; primarilyfor fabricating carbon-carbon composites



Primary Capabilities:

- Vacuum and pressurized operation
- Heated system

Special/Unique Capabilities:

- Vacuum and/or pressurized operation without opening system
- Can introduce liquid resins externally into the closed system

Equipment/Instrumentation:

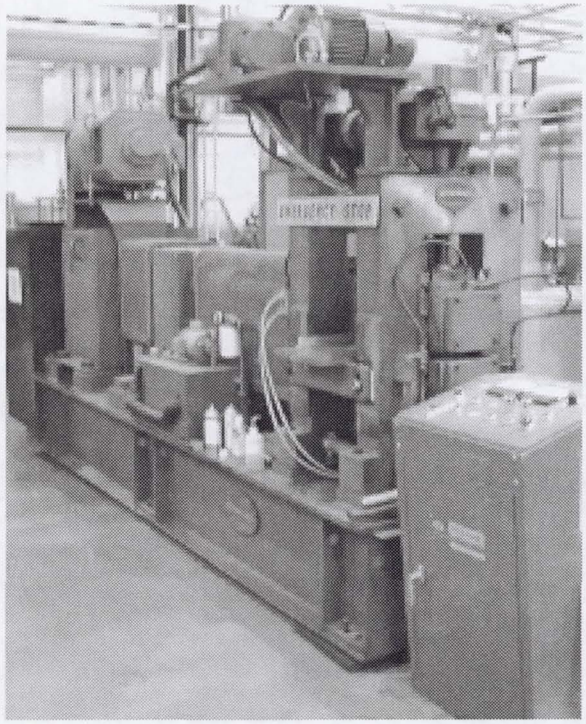
- Vacuum/inert (N_2)/air operation
- Pressure: 25 microns to 300 psig
- Programmable pressure and temperature control
- Temperature to 260°C (500°F)
- Hot wall and independently heated floor
- Horizontal cavity 16" i.d. x 27" L

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Rolling Mill

Purpose:
- Support research on the thermomechanical processing of metallic materials.



Primary Capabilities:
- Perform thermomechanical processing of metallic materials, e.g., reducing thick billets of metallic materials down to thin sheets; roll cladding; powder consolidation.

Special/Unique Capability:
- 9-in. wide x 10-in. diameter cold rolls and infrared heated hot rolls

Equipment/Instrumentation:
- Material capacity – 9-in. wide, 4-in. thick
- 40 HP drive motor
- Continuously variable roll speed up to 50 rpm

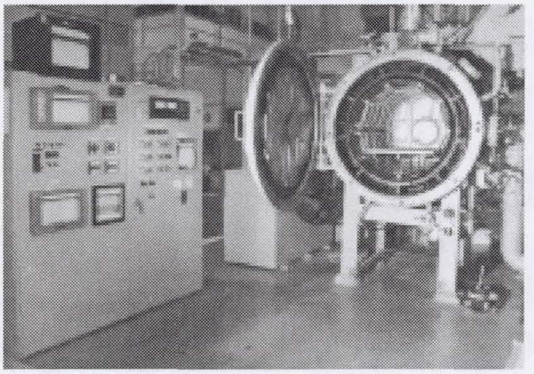
Point of Contact:
- Structures and Materials Laboratory Building 1148. Robert A. Hafley (757) 864-8078 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

ABAR Vacuum Furnaces

Purpose:
- Process metallic materials in a vacuum environment at temperatures up to 2500°F in support of center-wide research activities

Primary Capabilities:
- Heat treating and brazing of metallic materials

Special/Unique Capabilities:
- Working hot zone size:
  - ABAR II: 24 in W x 24 in H x 48 in L
  - ABAR III: 24 in W x 18 in H x 36 in L
- Vacuum pressure down to 2 x 10^{-6} torr
- Recirculating inert gas cooling system
- Partial pressure operation under He gas
- Supports working loads of 600 lbs at temperatures up to 2500°F (1000 lbs up to 2000°F)

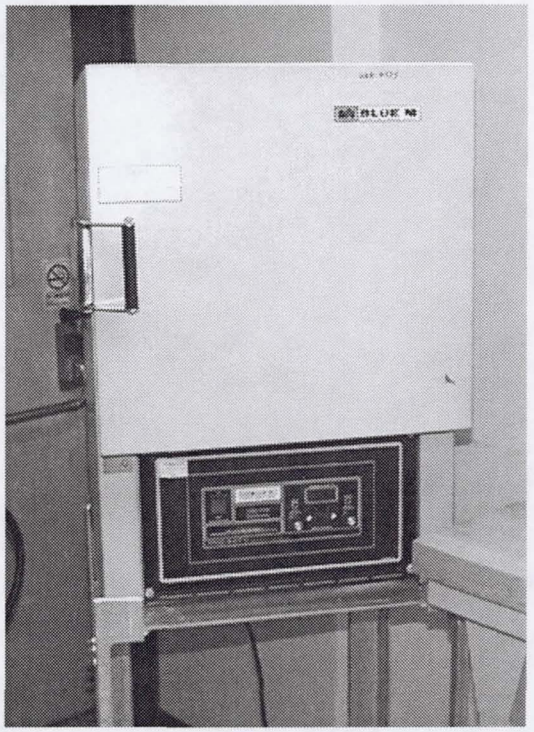


Equipment/Instrumentation:
- Manual/auto temperature control program
- Auto pump down
- Multiple thermocouples to read specimen and chamber temperature
- Temperature recorder
- Data acquisition of temperature/vacuum pressure/time profiles

Point of Contact:
- Structures and Materials Laboratory, Building 1148. Eric K. Hoffman (757) 864-3127 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Drying Ovens

Purpose:
- To dry ceramic powders; cure silver-epoxy electrodes on piezoelectric materials



Primary Capabilities:
- General purpose

Special/Unique Capabilities:
- Temperatures to 300°C (570°F)
- Two identical ovens

Equipment/Instrumentation:
- Maximum temperature 300°C (570°F)
- Air atmosphere
- Chamber 13" H x 12" W x 12" D

Point of Contact:
- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Processing Furnaces

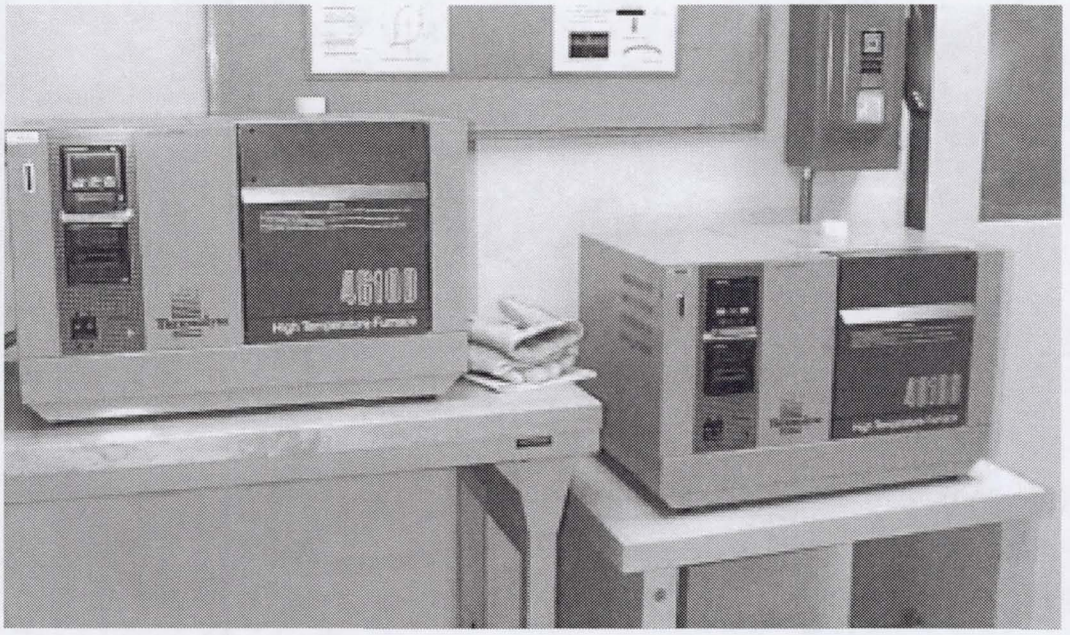
Purpose:
- To process ceramic materials

Primary Capabilities:
- General purpose

Special/Unique Capabilities:
- Temperatures to 1700°C
- Various furnaces (10) of differing sizes and configurations

Equipment/Instrumentation:
- Maximum temperature 1700°C
- Some furnaces have controlled atmosphere capability
- Tube furnaces to 4" dia.
- Muffle furnaces up to 8" W x 5" H x 14" D

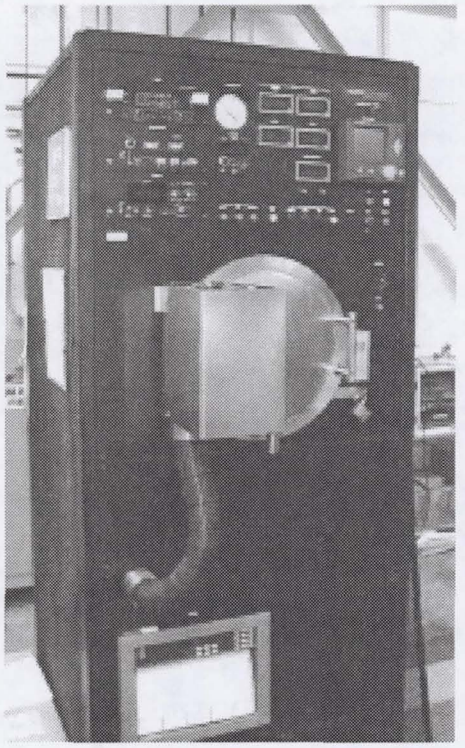
Point of Contact:
- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



Two-Parameter Mission Simulation System

Purpose:

- To conduct mission performance tests of high-temperature materials in realistically simulated service environments of pressure and temperature



Primary Capabilities:

- Simulation of pressure and temperature as a function of time

Special/Unique Capabilities:

- Temperature capability to (1650°C) 3000°F in air
- Any oxidizing gas (air, CO_2,)

Equipment/Instrumentation:

- 5" x 5" x 5" hot zone
- Pressures 10 microns to 1 atm
- Fully automated control

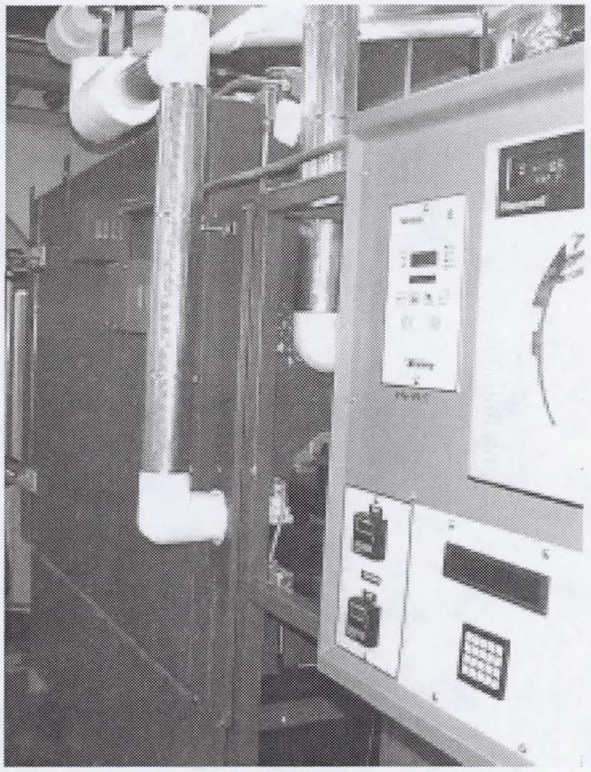
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Craig W. Ohlhorst (757) 864-3502 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Temperature/Altitude Simulation Chamber

Purpose:

- To conduct mission performance tests of polymer-based materials in realistically simulated airframe service environments of temperature and altitude



Primary Capabilities:

- Simultaneous simulation of altitude (pressure) and temperature as a function of time

Special/Unique Capabilities:

- Temperatures to 200°C (390°F)
- Altitudes to 75,000 ft

Equipment/Instrumentation:

- Temperature range: -57°C (-70°F) to 200°C (390°F)
- Altitudes: sea level to 75,000 ft
- Chamber dimensions 48" W x 48" D x 48" H

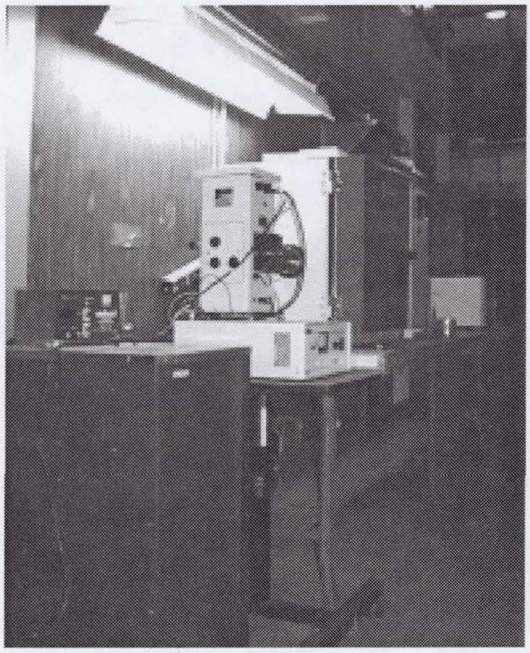
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Craig W. Ohlhorst. (757) 864-3502 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Thermal/UV/Moisture Cycling Test System

Purpose:

- Expose newly developed composites for spacecraft and aircraft to the extremes of service temperatures, UV, and moisture for the number of cycles representative of anticipated service lifetimes and monitor material microcrack development



Primary Capabilities:

- Accelerated cycling to accomplish many years of exposure within reasonable time periods

Special/Unique Capabilities:

- Variable xenon UV source
- Temperature and solar spectrum monitoring during exposure

Equipment/Instrumentation:

- Temperature ranges -250°F to +300°F
- Cooling-heating cycle: 1 hour
- Size of test articles: 12 specimens of 0.5-in.x 2-in.
- Solar spectrum (xenon lamp): up to 4X AM0

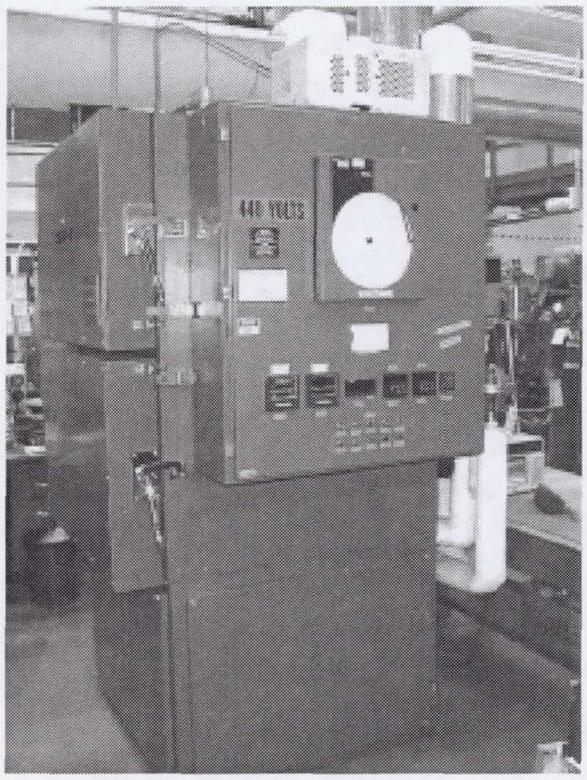
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Thermal Cycling Chambers

Purpose:

- Expose spacecraft and aircraft candidate materials to the extremes of service temperatures for the number of cycles representative anticipated in service



Primary Capabilities:

- Accelerated thermal cycling to accomplish many years of exposure within reasonable time periods

Special/Unique Capabilities:

- Several chambers of different sizes and capacity, enabling many materials, specimen sizes, and environmental conditions to be run simultaneously
- Temperatures from –185°C (-300°F) to 315°C (600°F)

Equipment/Instrumentation:

- Temperatures from –185°C (-300°F) to 315°C (600°F)
- Forced convection; liquid nitrogen for rapid cooling
- Largest test chamber 11" W x 9" D x 5" H
- Smallest test chamber 5" W x 3" D x 1" H

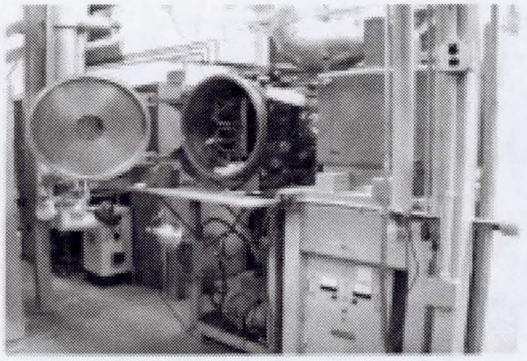
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Craig W. Ohlhorst (757) 864-3502 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Thermal Cycling & Solar Spectrum Exposure Chamber

Purpose:

- Expose spacecraft and aircraft candidate materials to the extremes of service temperatures and solar spectrum for the number of cycles representative of anticipated service lifetimes



Primary Capabilities:

- Accelerated thermal cycling to accomplish many years of exposure within reasonable time periods

Special/Unique Capabilities:

- Several chambers of different sizes and capacity, enabling many materials, specimen sizes, and environmental conditions to be run simultaneously
- Temperature and solar spectrum monitoring during exposure

Equipment/Instrumentation:

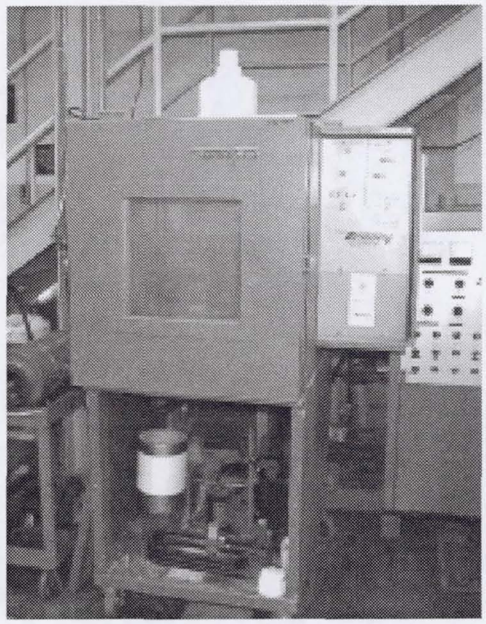
- Temperature ranges -250°F to +300°F
- Forced convection
- Liquid nitrogen for rapid cooling
- Size of test articles: 10-inch diameter
- Solar spectrum (xenon lamp): up to 4X AM0

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Humidity Chamber

Purpose:
- Condition specimens for moisture characterization studies



Primary Capabilities:
- Conditioning polymeric materials to humidity and temperature for moisture absorption and characterization studies

Special/Unique Capability:
- Large volume chamber to enable high specimen throughput

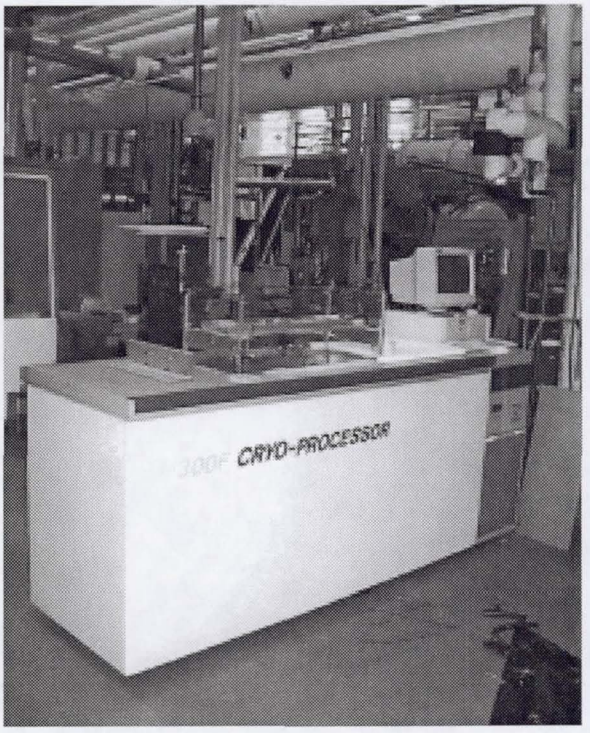
Equipment/Instrumentation:
- Inside dimensions 25" W x 19" D x 18" H
- Two shelves for supporting specimens
- Temperatures 25°C to 90°C
- Relative humdities 20% to 95%

Point of Contact:
- Structures and Materials Laboratory, Building 1148. Dr. Edward R. Long, Jr. (757) 864-4249 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Low-Temperature Thermal Treatment System

Purpose:

- To determine the response of packaged spacecraft thin films to unfolding while in the cryogenic environment of space



Primary Capabilities:

- Expose candidate spacecraft materials to extended low-temperature thermal soaks
- Materials treatment under cryogenic temperature

Special/Unique Capabilities:

- Temperature down to –185°C under LN_2
- Use of liquid helium possible for 50 °K drop
- Change rate in temperature: 0.5 °C/min as the slowest
- Programmable temperature control

Equipment/Instrumentation:

- Temperature down to –185°C
- Optical system to observe damage in-situ
- Wrinkling level and force measurement of unfolding inflatable membranes
- Digital CCD camera monitoring of specimen during test period

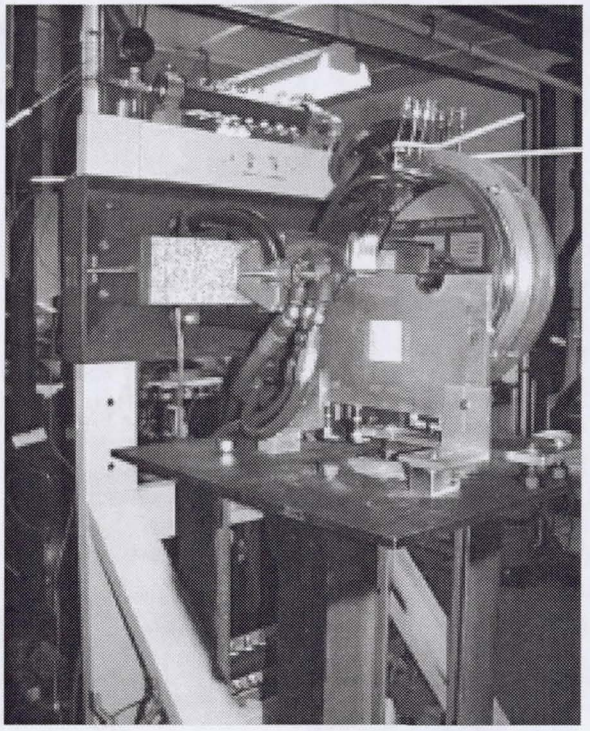
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

High-Heat Flux (HHF) Facility

Purpose:

- To determine materials performance at ultra-high temperatures; to conduct various tests requiring very high heat fluxes



Primary Capabilities:

- Drive materials to very high temperatures

Special/Unique Capabilities:

- Arc plasma source (optical heating)
- Controlled atmosphere environment for test specimen
- Temperature capability in excess of 3000°K
- Heating rate controllable
- Temperature monitoring by IR

Equipment/Instrumentation:

- Pseudo-black-body emission from 6500° K argon plasma
- 40 kW and 60 kW optical power
- Concentration up to approx. 8000 Solar constants
- Test temperatures in excess of 3000°K
- Test zone 10 mm dia. x 150 mm L
- Controlled gas environments

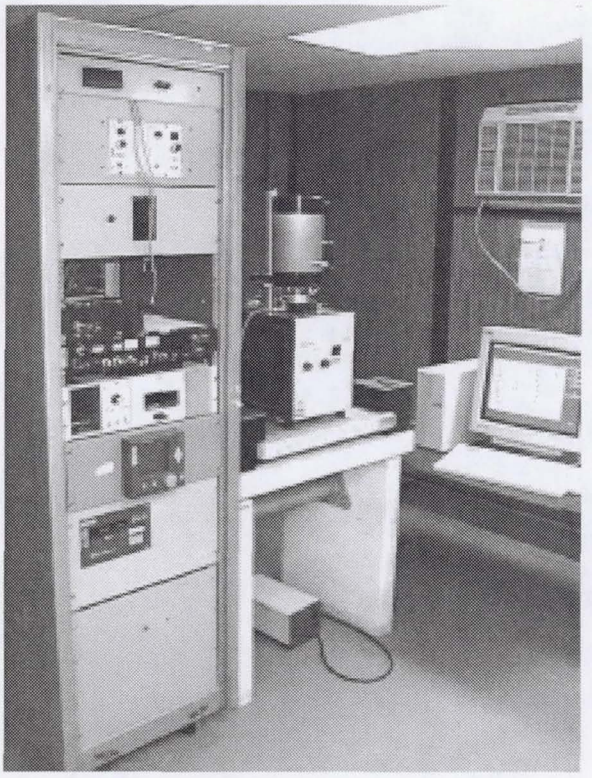
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

High-Temperature Thermogravimetric Analysis (TGA)/Differential Thermal Analysis (DTA) System

Purpose:

- To measure small changes in material mass or enthalpy during exposure to very high temperature in selected test atmospheres



Primary Capabilities:

- Mass change measurements to 1600°C (2900°F)

Special/Unique Capability:

- Temperature capability to 1600°C (2900°F)

Equipment/Instrumentation:

- Vacuum, inert gas, or air operation
- Programmable pressure control
- Specimens up to: 0.5-in. x 0.5-in.
- Mass change sensitivity: 0.1 mg

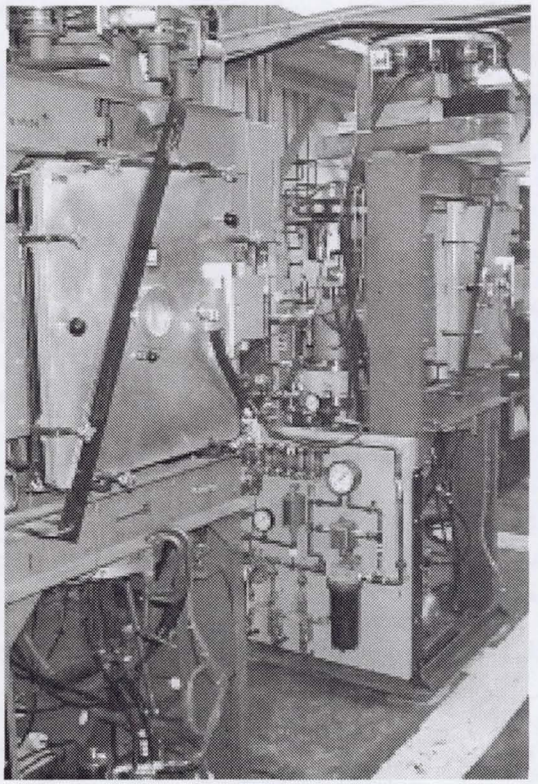
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Multiparameter Environmental Simulators

Purpose:

- To conduct mission performance tests of high-temperature materials in realistically simulated service environments, including pressure, temperature, and tensile loading



Primary Capabilities:

- Simulation of pressure, temperature, and tensile loading as a function of time

Special/Unique Capabilities:

- Temperature capability to 1650°C (3000°F) in air
- Any oxidizing gas (air, CO_2,)
- Three identical and independent test stands

Equipment/Instrumentation:

- 18-specimen capability
- Specimens up to 21" in length
- Pressures 10^{-2} microns to 1 atm
- Tensile load to 2000 lb.
- Fully automated control

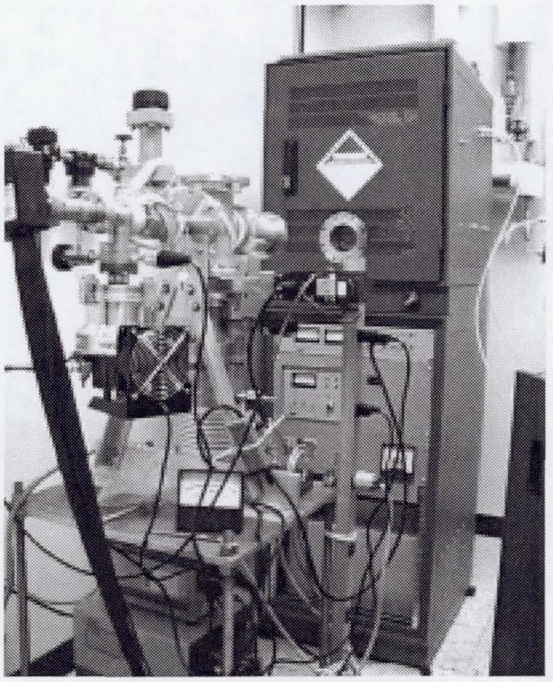
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Craig W. Ohlhorst (757) 864-3502 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Atomic Oxygen/Vacuum Ultraviolet Exposure System

Purpose:

- Measure the erosion resistance of spacecraft materials to atomic oxygen, either alone or in combination with vacuum ultraviolet radiation



Primary Capabilities:

- Atomic oxygen and vacuum ultraviolet exposure of materials

Special/Unique Capability:

- AO or combined AO plus VUV capability

Equipment/Instrumentation:

- RF discharge high-purity AO plasma
- AO variable flux up to 3×10^{16} O's/cm^{2}sec
- AO energies up to 0.4 eV
- VUV wavelength range: 110 nm ~ 250 nm
- VUV intensity: 2 equivalent sun's UV (2X AM0)
- Vacuum pressure: 5 ~ 100 mtorr

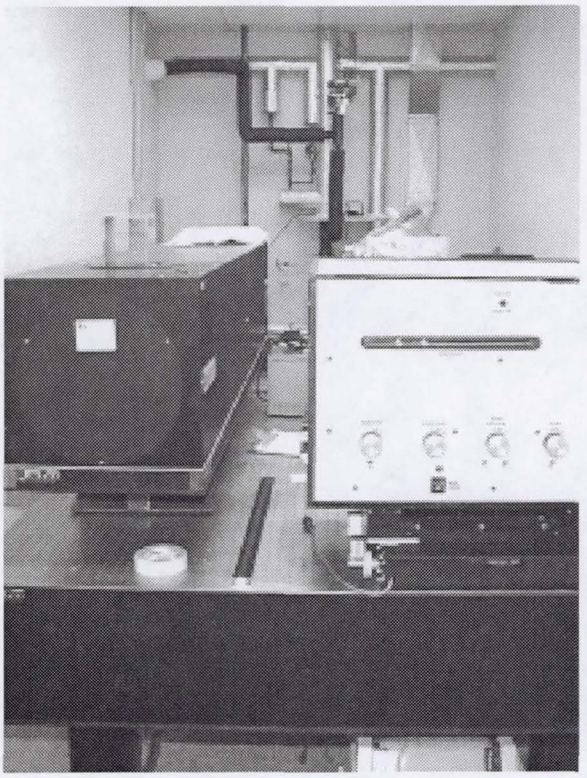
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Surface Accuracy Interferometer

Purpose:

- Measure the surface figure and roughness of reflector (mirror) panels.



Primary Capabilities:

- Measure surface accuracy on flat and curved panels

Special/Unique Capabilities:

- Measure surface accuracy as a function of temperature
- Combined thermal cycling and vacuum capability

Equipment/Instrumentation:

- Temperature range: ± 250°F
- Atmospheric pressure and vacuum operation
- Maximum specimen size 10-in. dia.
- Wavelength: 10.6 μm
- 10-in. dia. collimated and diverging beams
- Resolution: 0.2 μm

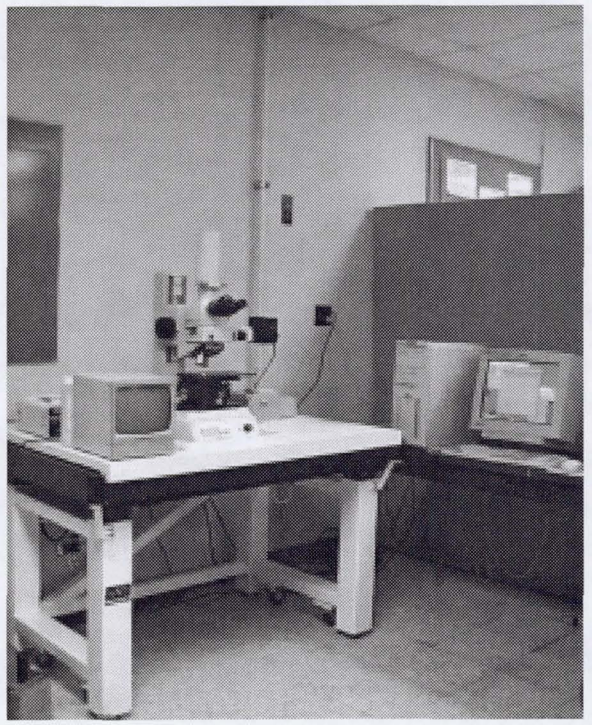
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sheila A. Thibeault (757) 864-4250 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Focus Scanning Interferometric Microscope

Purpose:

- High-resolution measurements of surface roughness and crack-depth and width in materials



Primary Capabilities:

- Measurement of depth and width of microcracks and surface roughness

Special/Unique Capability:

- Interferometric fringe pattern determines surface roughness, depth, width, and displacement.

Equipment/Instrumentation:

- Scanning range: 100 μm with piezoelectric platform
- X-Y translation
- Digitized video data
- Computer controlled video gain and offset control
- PZT amplifier and LCD display of scan position
- Smart turret: automatically changes the magnification in software
- Confocal mode imaging: phase detection process

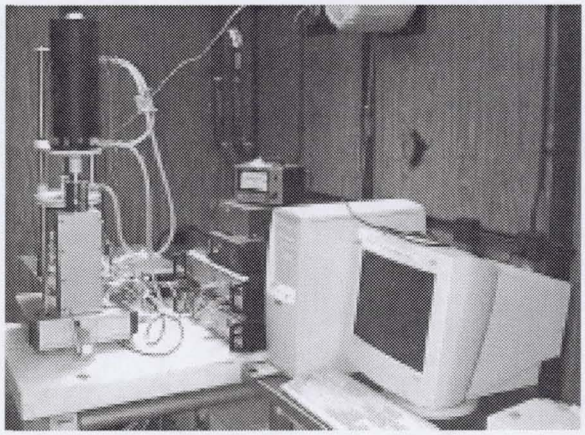
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

High-Temperature Dilatometer

Purpose:

- To measure the coefficient of thermal expansion (CTE) of materials up to very high temperatures



Primary Capabilities:

- CTE measurements to 1550°C (2820°F)

Special/Unique Capability:

- CTE measurements to 1550°C (2820°F)

Equipment/Instrumentation:

- Vacuum, inert gas, or air operation
- Alumina single push rod
- Specimens: 0.25" dia. up to 1" long

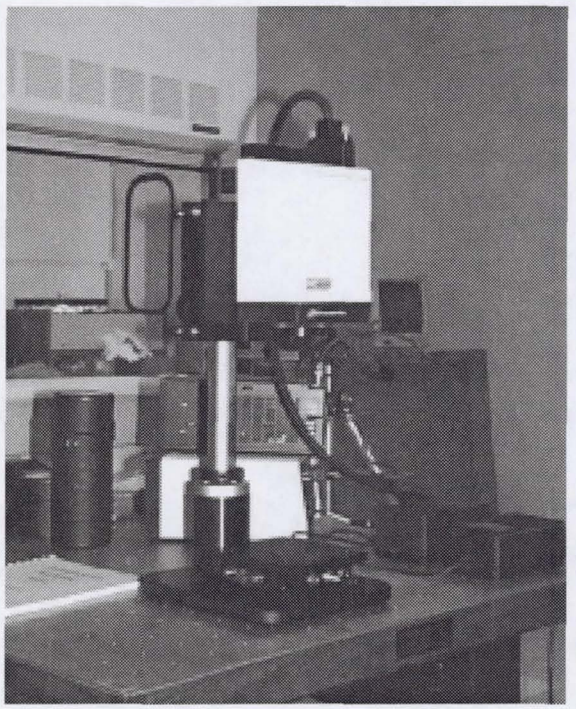
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Wallace L. Vaughn (757) 864-3504 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Thermal Imaging Camera

Purpose:

- High-resolution measurements of temperature and thermal gradients in materials



Primary Capabilities:

- Thermal contours of materials

Special/Unique Capability:

- Temperature contour resolution of 30 μm from a distance of 5 cm.

Equipment/Instrumentation:

- Temperature spatial resolution of 30 μm from a distance of 5 cm.
- Temperature measurement to 3000°K with 60 cm focus telephoto lens

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sang H. Choi (757) 864-1408 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Laser Interferometric Dilatometer

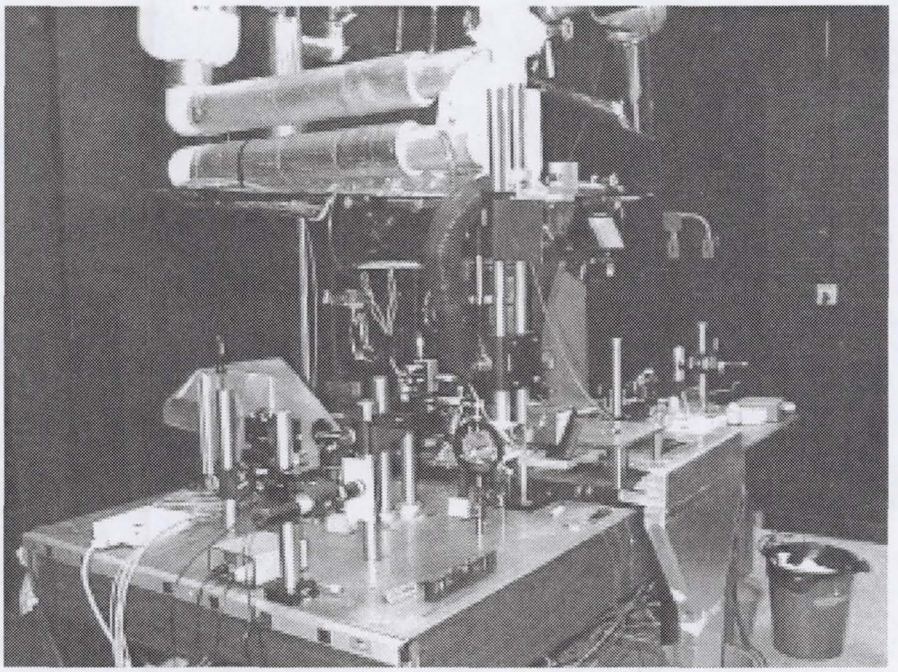
Purpose:
- To measure thermal expansion behavior of low expansion materials

Primary Capabilities:
- Highly accurate measurement of coefficients of thermal expansion (CTEs)

Special/Unique Capability:
- Three identical systems; calibrations traceable to National Bureau of Standards

Equipment/Instrumentation:
- Temperature range ± 250°F
- Atmospheric pressure (nitrogen)
- Specimen size 3" x 1"
- Strain resolution 0.5 x 10-6/°F

Point of Contact:
- Structures and Materials Laboratory, Building 1148. Craig W. Ohlhorst (757) 864-3502 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



Dynamic Mechanical Analyzer/Thermomechanical Analyzer

Purpose:

- Measure glass transition temperature, modulus, damping characteristics, and coefficient of thermal expansion of polymeric materials

Primary Capabilities:

- Determine selected fundamental properties of polymer and polymer composites

Special/Unique Capabilities:

- Temperature to 600°C (1110°F)
- Fully automated system

Equipment/Instrumentation:

- Temperature range -145°C (-230°F) to 600°C (1110°F)
- Displacement range: 25 mm
- Loading force: 0.001 to 18 N
- Controlled flow with air or inert gas
- Modulus range: 103 Pa to 3x1012 Pa
- Dynamic deformation: ±0.5 to 10,000 μm
- Strain resolution: 1 nm

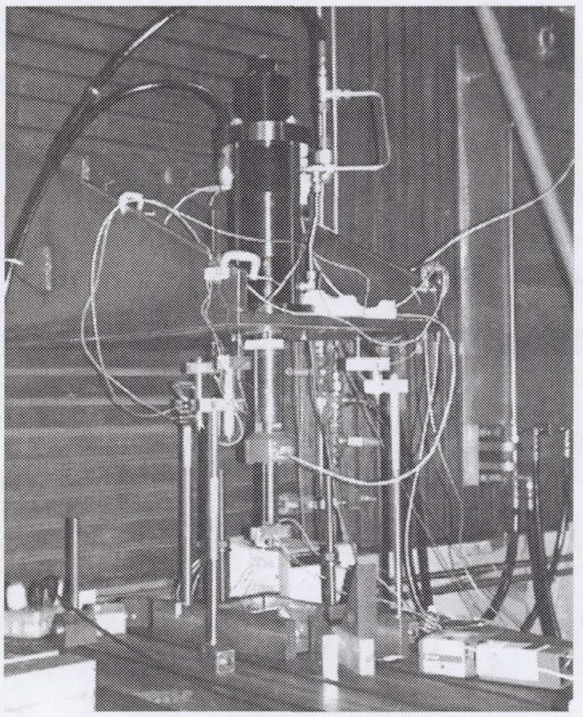
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sheila A. Thibeault (757) 864-4250 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Static Indentation Test Setup

Purpose:

- To impart static indentation damage to structures
- To determine load vs. deflection response of plate structure



Primary Capabilities:

- Damage tolerance studies of composite structures
- Quasi-static loadings to simulate low-speed impact

Special/Unique Capabilities:

- Displacement or load control
- Hydraulic servo system interfacing with data acquisition system

Equipment/Instrumentation

- 5000 lb capacity actuator with 4-in. stroke
- 500 lb and 1000 lb load cells
- 0.5-in, 0.625-in., and 1.0-in. diameter hemispherical indentors.
- 6ft x 3ftx3ft T-slotted support table
- High speed data acquisition system, 32 channels each at 10,000 samples/sec for 64 sec.

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Branch Head: Dr. Damodar R. Ambur (757) 864-3174

Dropped-Weight Impact Apparatus (50 ft-lb)

Purpose:

- Characterization of composite structural response when subjected to low-speed impact

Primary Capabilities:

- Dropped weight impact energies from 0.5 to 50 ft-lb.
- 5-ft maximum drop height with motor driven height adjustment
- Accurate drop of intended locations
- Two limit switches to ensure safe operation

Equipment/Instrumentation

- Three dropped weights: 2.5, 5.0, and 10. lbs
- 0.5-in., 0.625-in., and 1.0-in. diameter hemispherical impactors
- 32 data channel data acquisition at 1,000,000 samples per sec for 64 sec.
- 3000, 5000, and 10,000 lb Dynatup force transducers for contact force measurement.
- Tilt-table with t-slotted specimen support surface
- MTI-2000 Fotonic sensor using fiber optics technology for transient deflection measurement.
- Variety of fixtures to accommodate flat and curved panels with combinations of simply supported and/or clamped boundary conditions.

Special/Unique Capabilities:

- Dropped weight bounce-back braking mechanism prevents repeat impacts
- External trigger for data acquisition.
- Impact response of structure in the form of contact forces, deflections, and strains acquired by high-speed data acquisition system.
- Oblique impact capability

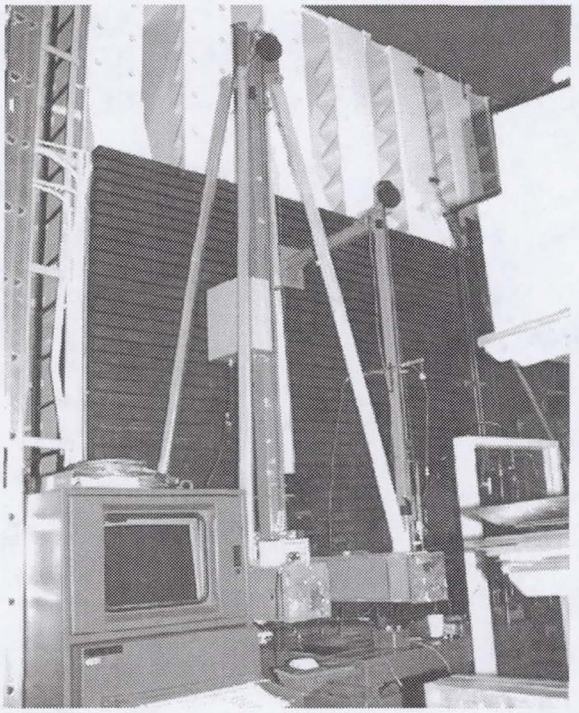
Point of Contact:

- Structures and Materials Laboratory Building 1148. Branch Head: Dr. Damodar R. Ambur (757) 864-3174

Dropped Weight Impact Apparatus (175 ft-lb)

Purpose:

- Characterization of composite structural response when subjected to low-speed impact



Primary Capabilities:

- Dropped weight impact energies from 0.5 to 175 ft-lb.
- 7-ft maximum drop height with motor driven height adjustment
- Accurate drop of intended locations

Special/Unique Capability:

- Self-contained unit. Can be moved to other locations to impact large structures, i.e. wings, fuselages

Equipment/Instrumentation:

- Two dropped weights: 20 lb and 25 lb
- 1.0-in. diameter hemispherical impactor
- 32 data channel data acquisition at 1,000,000 samples per sec. for 64 sec.
- 3000, 5000, and 10,000 lb Dynatup force transducers for contact force measurement.

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Branch Head: Dr. Damodar R. Ambur (757) 864-3174

Clean Room

Purpose:

- To execute operations requiring ultra-clean environment, including layup and fabrication of precision composite reflector panels

Primary Capabilities:

- Ultra-clean environment for critical operations

Special/Unique Capability:

- Clean bench within a clean room

Equipment/Instrumentation:

- Clean bench in clean room
- Class 100 – 1000 clean room (7 ft x 13 ft)
- Class 10,000 pre-clean room (20 ft x 18 ft)
- Fume hood and lab sink in pre-clean room
- Locking doors to both rooms

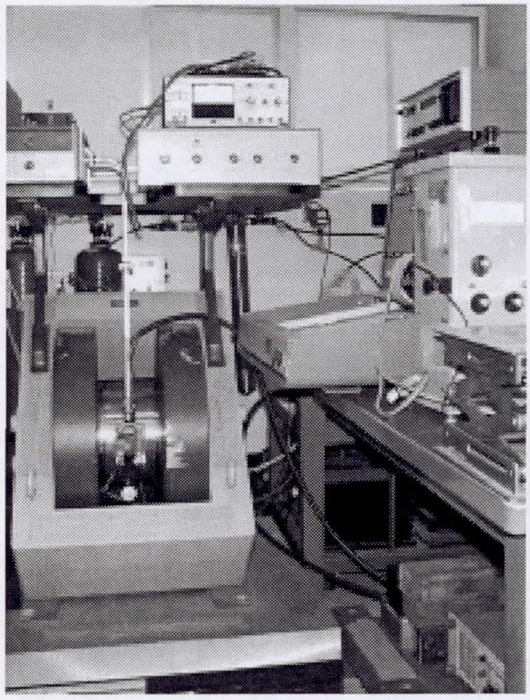
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sheila A. Thibeault (757) 864-4250 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Electron Paramagnetic Resonance Imaging Spectrometer

Purpose:

- Analysis of radicals formed within polymers due to environmental exposures or other external stresses



Primary Capabilities:

- Establish fundamental information concerning chemical processes within polymeric materials

Special/Unique Capabilities:

- Imaging capability
- Determine readicals as a function of depth

Equipment/Instrumentation:

- Electromagnet: 7000 Gauss
- Microwave bridge: 9.5 GHz
- Temperature 185°C (-300·F) to 300°C (570°F)
- In-situ UV exposure
- Automated data acquisition
- Microwave frequency counter
- Gaussmeter

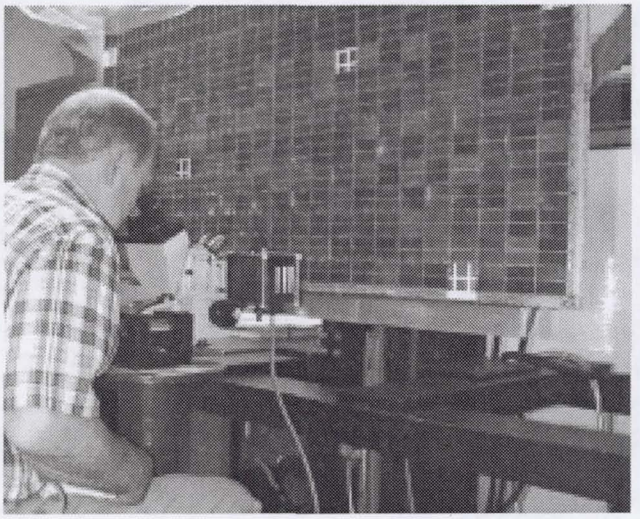
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Sheila A. Thibeault (757) 864-4250 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Meteoroid and Debris Microscope Scanning System

Purpose:

- Scan spacecraft components for meteoroid and debris damage to provide information on the nature of and the flux of the impactors



Primary Capabilities:

- Traverse tables with stand-mounted microscopes for crater counting and examination

Special/Unique Capability:

- Two complete systems, with photographic capability

Equipment/Instrumentation:

- Traverse tables hold spacecraft components up to 1.3 m x 1.0 m
- Traverse ranges: 960 mm left/right; 480 mm up/down; 480 mm in/out
- Scanning rates: 0.1 mm/s to 16 mm/s, with jog capability
- Microscope power: 50X to 800X
- Photographic capabiltiy

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Donald H. Humes (757) 864-1484 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Outgassing System

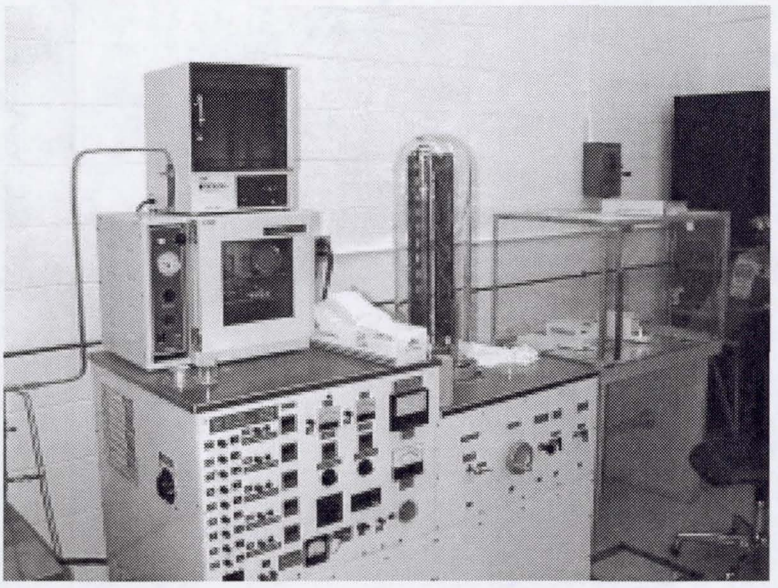
Purpose:
- Measure outgassing characteristics of materials

Primary Capabilities:
- Establishes weight loss of and recondensables from materials due to outgassing in vacuum

Special/Unique Capabilities:
- Conforms to ATM Standard E595
- Evaluates a material's compliance with outgassing requirements for service in space: <1.0 % outgassing and <0.1 % recondensables

Equipment/Instrumentation:
- 10^{-7} torr vacuum
- 125°F exposure temperature
- 25°F collection temperature

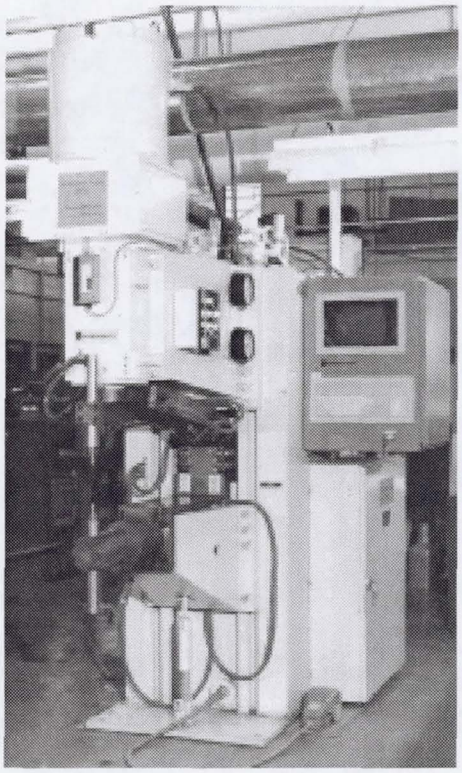
Point of Contact:
- Structures and Materials Laboratory, Building 1148. Dr. Edward R. Long, Jr. (757) 864-4249 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



Sciaky Resistance Spot Welder with Weld Computer Controls

Purpose:

- Welding equipment used to join two or more overlapping metallic sheets in support of center-wide research activities



Primary Capabilities:

- Resistance spot welding of aluminum, titanium, and steel sheet products up to 1/4 inch or more in thickness

Special/Unique Capabilities:

- 460V, 200 kVA, 3-phase frequency converter power supply
- Press-type machine with programmable upper and lower air cylinders for control of weld and forge force
- 36-in throat depth
- Programmable controls
- Monitoring and data acquisition of weld nugget expansion, electrode force, weld current, power, and conductance as a function of weld cycle time
- Adaptive feed back controls that compensate for variations in workpiece thickness, workpiece resistivity due to surface oxides/cleanliness, power line fluctuations, air pressure variations, etc.

Equipment/Instrumentation:

- Adaptive feedback
- LVDT for measuring weld nugget expansion
- In-line load cell for measuring electrode weld and forge forces

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Eric K. Hoffman (757) 864-3127 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Structural Backstop Facility

Purpose:

- To conduct experiments on varied and unique large-scale structural components.

Primary Capabilities:

- 10-ft x 30-ft T-slotted steel reaction surface for testing structural components
- Steel beams embedded in floor for actuator or specimen attachment
- 3000 psi hydraulic system for actuatoractivation

Special/Unique Capability:

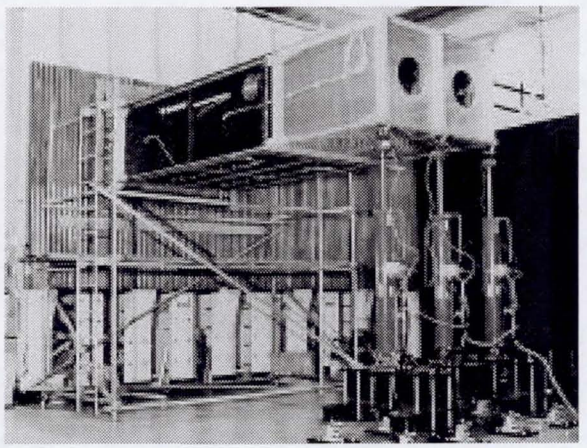
- Actively controlled multi-actuator capability for load application

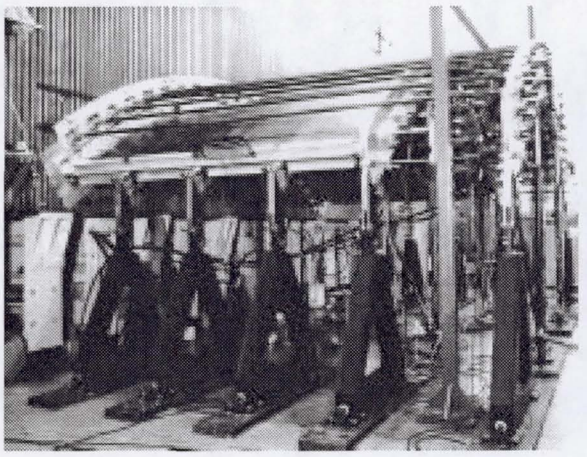
Equipment/Instrumentation:

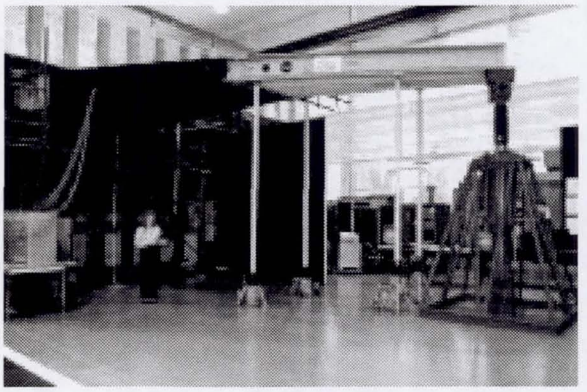
- Data Acquisition system - 512 channels (typical, 320 additional channels available) with realtime plots and engineering units readout

Point of Contact:

- Structures and Materials Laboratory, Building 1148. Branch Head: Dr. Damodar R. Ambur (757) 864-3174



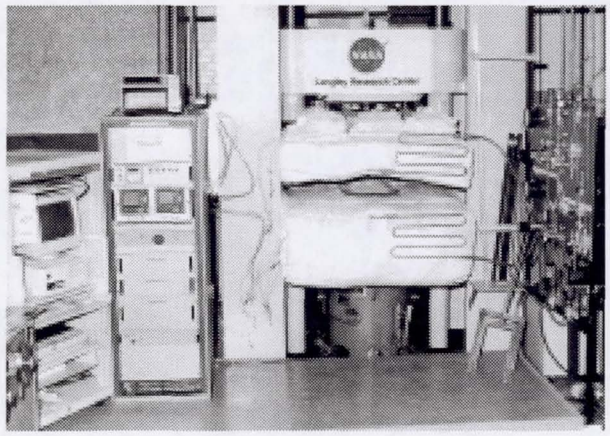




Superplastic Forming Press

Purpose:

- Used primarily to superplastically form aluminum alloy sheet for incorporation into skin stiffened and sandwich sub-elements. Typical size is ~ 18 in. L x 6 in. W.



Primary Capabilities:

- Differential pressure forming with back pressure capability using inert gas.
- Typical Al alloys formed: Al-Cu 2004, 2124 and 2424, Al-Li 2090, 2095 and 8090, Al-Mg 5083, Al-Zn 7475

Special/Unique Capabilities:

- Test coupon size – 30 in. x 11 in.
- Maximum temperature – 1000°F
- Maximum pressure – 500 psi
- Forge force – 300,000 lbs
- Die configurations – Female cavity with plain, stepped and beaded web hat stiffener inserts, isogrid tooling, multiple cone testing die

Equipment/Instrumentation:

- Programmable temperature and pressure controls. Digital temperature and pressure data acquisition.

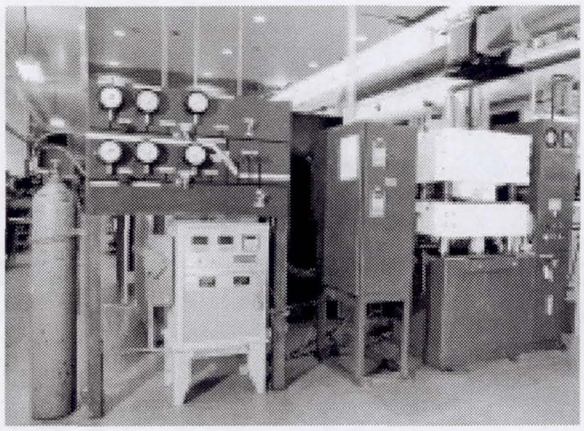
Point of Contact:

- Structures and Materials Laboratory, Building 1148. Dr. Stephen Hales (757) 864-3128 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431.

Superplastic Forming Cone Tester

Purpose:

- Support research to assess the biaxial formability of superplastic aluminum alloy sheet as a function of temperature and strain rate.



Primary Capabilities:

- Differential pressure forming with back pressure capability using inert gas.
- Typical Al alloys formed: Al-Cu 2004, 2124 and 2424, Al-Li 2090, 2095 and 8090, Al-Mg 5083, Al-Zn 7475

Special/Unique Capabilities:

- Starting blank dimensions – 9 in. x 6 in.
- Maximum temperature – 1000°F
- Maximum pressure – 500 psi
- Forge force – 64,000 lbs
- Die configurations – 60° cone (2 in. and 2.5 in. dia.), loaf pan, isogrid

Equipment/Instrumentation:

- Manual temperature and pressure controls.

Point of Contact:

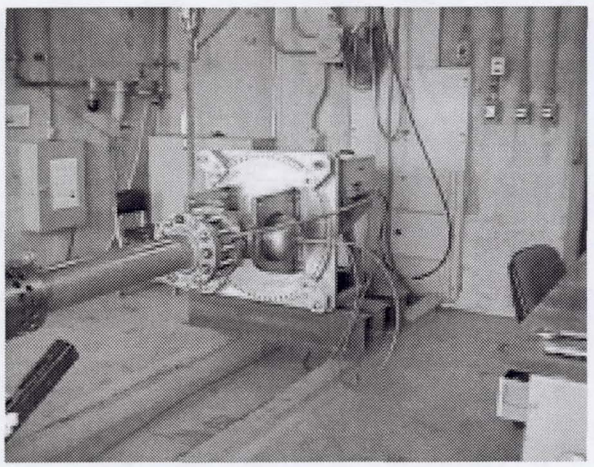
- Structures and Materials Laboratory, Building 1148. Dr. Stephen Hales (757) 864-3128 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431.

Cryogenic And Room Temperature Pressure Box Test Facility (Bldg 1160/61)

Gas-Actuated Specimen Penetration Device

Purpose:

- To simulate aircraft engine turbine blade fragment impact and study the response and damage characteristics of metallic and composite structures.



Primary Capabilities:

- Equipped with two gun barrels one to shoot a 0.5-in.-diameter sphere and the second to shoot a flat plate fragment of up to 5.5-in.-wide and 0.25-in. thick
- Fragment impactor weight: 0.05 lb to 3 lb (including the sabot weight)
- Impact velocity: Up to 1200 ft/sec for 0.05 lb weight and 700 ft/sec for 3 lb weight (total weight of fragment impactor and sabot)

Special/Unique Capabilities:

- Guides the impactor (fragment and sabot) through the gun barrel at a user selected impact attitude (5° increments for roll angle and 15° increments for pitch and yaw angles with respect to the specimen).
- Captures the sabot inside the gun barrel and delivers only the fragment

Equipment/Instrumentation:

- Dynamic data acquisition system: 32 channels of strain or displacement data at 1,000,000 samples/sec for 64 seconds.
- High-speed camera with 13,000 frames/second for 20 seconds.

Point of Contact:

- Cryogenic and Room-Temperature Pressure Box Test Facility, Building 1161. Branch Head: Dr. Damodar R. Ambur. (757) 864-3174

Room Temperature Pressure Box Test Machine

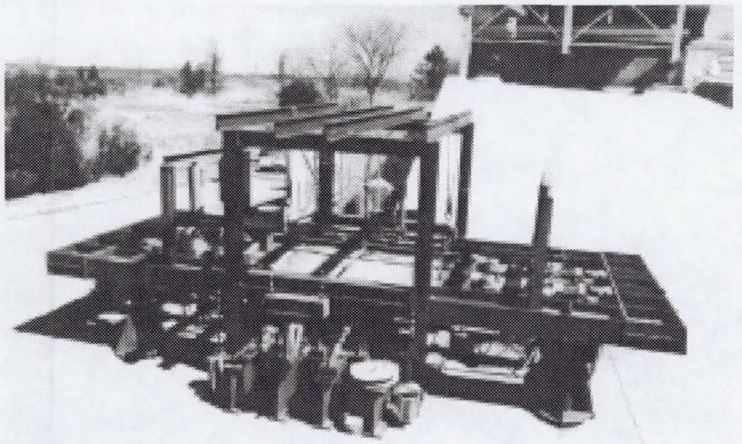
Purpose:
- To investigate the structural behavior of curved panels subjected to biaxial tension and internal pressure loading.

Primary Capabilities:
- Applied axial tension loading up to 450 kips
- Internal pneumatic pressure loading up to 20 psig
- Cyclic loading capability
- Applies loads to panels with up to three circumferential frames spaced 20- to 22-inch apart
- Specimen dimension: 122-inch radius, 72-inch length, 63-inch arc width

Special/Unique Capabilities:
- Accommodates curved stiffened fuselage panel with radii varying from 120- to 125-inches
- Hoop loads in skin and frame reacted through separate turnbuckles

Equipment/Instrumentation:
- Data aquisition; 512-channels
- Instrumented turnbuckles react hoop load due to internal pressure

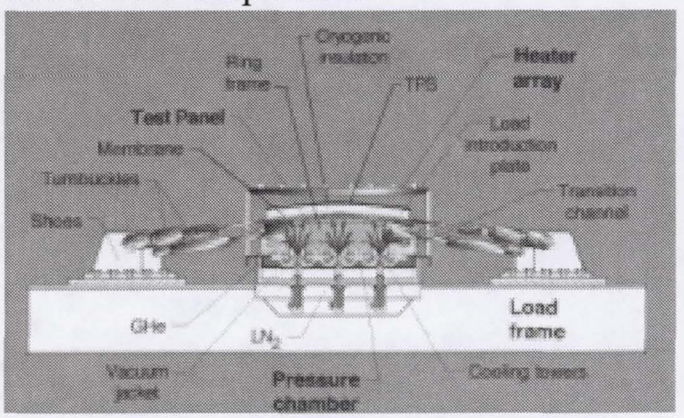
Point of Contact:
- Cryogenic and Room-Temperature Pressure Box Test Facility, Building 1161. Marshall Rouse (757) 864-3182 or Branch Head: Dr. Damodar R. Ambur (757) 864-3174



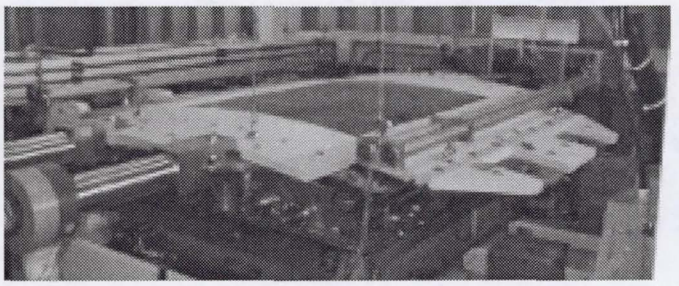
Cryogenic Pressure Box Facility

Purpose:
To investigate the structural behavior of full-scale curved cryogenic tank panels subjected to biaxial tension, internal pressure and temperature.

Primary Capabilities:
- Applied axial tension loading up to 450 kips
- Internal pneumatic pressure loading up to 54 psig
- Cyclic loading capability
- Internal cooling and heating to -423°F and 250°F respectively
- External heating to 1000°F with a heater array
- Panel size is 65 in. x 761/2 in.



Cross-section Schematic of Facility.



Special/Unique Capabilities:
- Accommodates curved stiffened panel tank section panels ranging from 130 in. to 266 in. (80 in. is possible)
- Hoop loads in the skin and ring frames reacted though separate turnbuckles
- Panels can have internal and external ring frames and stringers
- Cryogenic and high temperature test ability

Equipment/Instrumentation:
- Data acquisition: 512-channels (Thermocouples, Diodes, Strain Gages, and LVDTs)
- Instrumented turnbuckles to react hoop load due to ton internal pressure

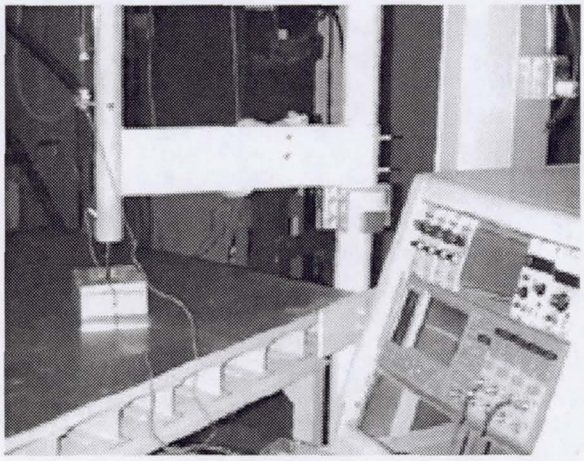
Points of Contact:
- Hazardous Test Area, Building 1161. Dr. Theodore F. Johnson (757) 864-5418 or Branch Head: Dr. Damodar R. Ambur (757) 864-3174

Materials And Research Laboratory (Bldg 1205)

Dropped-Weight Impact Test Machine (300 ft-lb.)

Purpose:

- To investigate the low-speed impact response of materials.



Primary Capabilities:

- Measurement of the impact force history
- Produce impact damage in coupons in preparation for subsequent compression-after-impact testing.
- 5,000- and 20,000-lb impact tups
- Impacter masses from 3.7 to 30 lbs.
- Maximum impactor velocity: 26 ft/sec
- Maximum impact energy: 300 ft-lbs.

Special/Unique Capability:

- Maximum specimen width: 45 in.

Equipment/Instrumentation:

- Data acquisition rates up to 10^7 hertz
- 4 digitally recorded channels

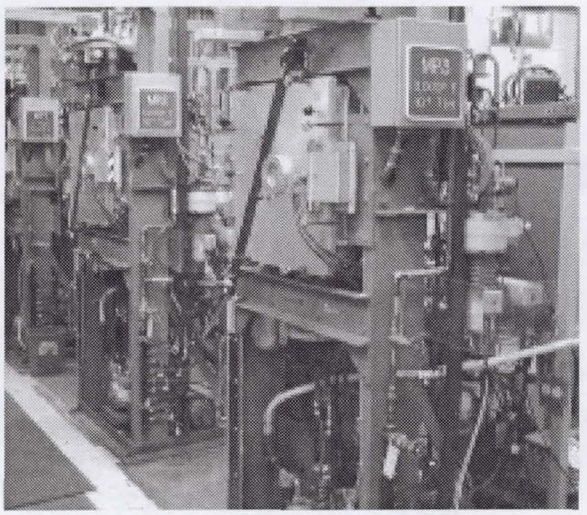
Point of Contact:

- Materials Reserach Laboratory, Building 1205. Wade Jackson, (757) 864-3468 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173

Multiparameter Simulator

Purpose:

- To evaluate the effect of flight missions on material properties and protective coatings by exposing coupons to realistic simulated mission environments.



Primary Capabilities:

- Vacuum chambers equipped with heating elements and load trains for exposing specimens to simulated mission profiles. All three variables, temperature, pressure, and load, are computer programmable and controlled to simulate anticipated flight conditions for orbital and suborbital missions.

Special/Unique Capabilities:

- Ability to program and independently vary all three parameters (temperature, pressure, load) simultaneously.
- Ability to achieve maximum temperatures up to either 1800°F or 3000°F.

Equipment/Instrumentation:

- Equipment : One stand equipped with Ni heating elements & load
  Three stands equipped with Pt heating elements & no load
- Temperature : Ni heating elements 68°F to 1800°F
  Pt heating elements 68°F to 3000°F
- Pressure : 760 torr to $5x10^{-6}$ torr at 68°F
  760 torr to $1x10^{-4}$ torr at 1500°F
- Load : Pin loaded specimens
  Six independent load trains
  Maximum capability 2000 lbs., tensile

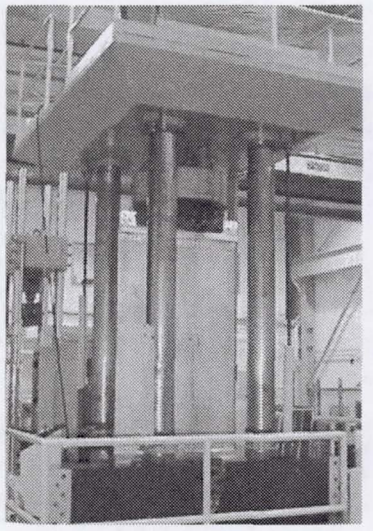
Point of Contact:

- Materials Research Laboratory, Building 1205. Karen B.Taminger (757) 864-3131 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Structural Fatigue and Fracture Test Equipment

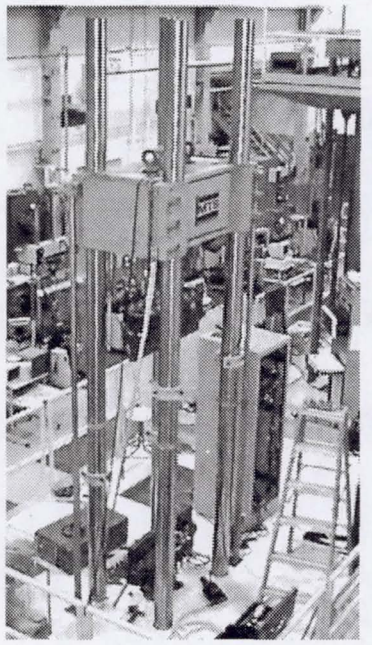
Purpose:

- To experimentally determine the durability and damage tolerance properties of materials and structural sub-components subjected to mechanical loading conditions.



Primary Capabilities:

- Test for durability and damage tolerance properties of materials using ASTM standards and in-house developed procedures. Test types include crack propagation, fracture toughness, and residual strength of materials and structural concepts.
- 300,000 and 400,000 lb. load capability
- Maximum specimen length: 8 ft.
- Test frequency limited only by specimen stiffness



Special/Unique Capability:

- Vacuum and environmental chambers

Equipment/Instrumentation:

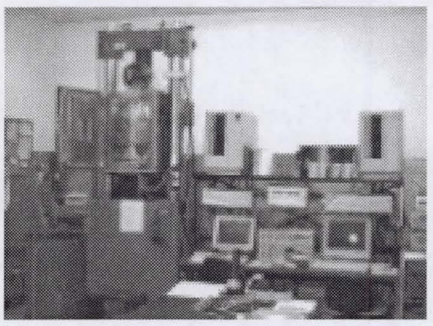
- Spectrum loading and data acquisition
- 36-inch-wide mechanically fastened grips

Point of Contact:

- Materials Research Laboratory, Building 1205. Dick Everett (757) 864-3459 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173

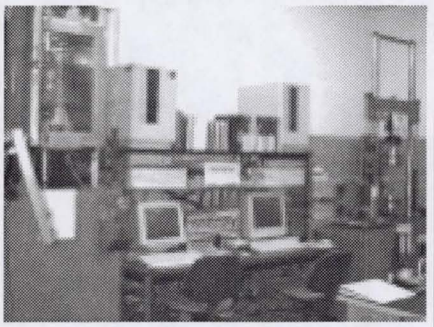
High Temperature Mechanics of Composites Laboratory

Purpose: To experimentally characterize elastic, inelastic and viscoelastic behavior of materials under static and dynamic mechanical loading.



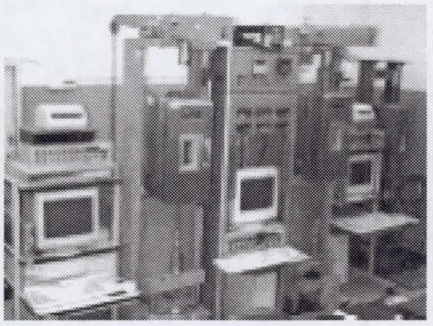
MTS Axial/Torsional Test stand

- 5000 lb axial, 2500 lb torsional maximum loads
- Biaxial modes: servo-hydraulic
- Digital control & acquisition
- Dynamic/Static material characterization
- Environmental chamber: –30→300°C
- Hydraulic and mechanical wedge grips



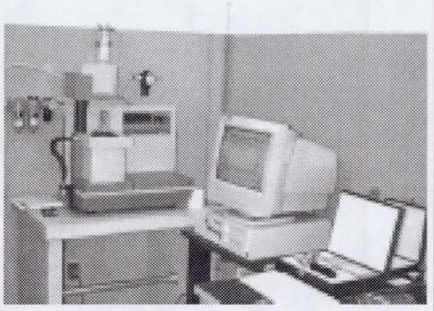
MTS Axial Test stand

- 20000 lb maximum axial load
- electro-mechanical
- Digital control & acquisition
- Dynamic/Static material characterization
- Hydraulic and mechanical wedge grips



Satec Mechanical Creep Test stands

- 4 Cantilever-arm, dead weight stands and 1 In-line dead weight stand
- All stands equipped with Applied Test Systems environmental chambers: RT→300°C
- Uniaxial tension/compression
- Digital control & acquisition
- Time-dependent material characterization
- Mechanical wedge grips



TA Instruments Dynamic Mechanical Analyzer

- 18 N max. force, modulus range $10^3 \rightarrow 10^{12}$ Pa
- Multi-mode deformation: Temperature ramp, single-/multi-frequency, constant strain – 3 point bend, single/dual cantilever
- Environmental chamber: –150→600°C, inert gas, heating/cooling rates: 0→20°C/min
- Digital control & acquisition

Long Term Durability Testing Facility

Purpose:

- To determine the long term durability of materials subjected to simultaneous thermal and mechanical loads

Primary Capabilities:

- Simulated flight profile testing or any combination of load and temperature profiles.
- Environmental chamber temperature range: –240°F to 650°F
- Maximum load frame capacity: 55,000 lb. tension/compression
- 12 servohydraulic stands with 55,000 lb. load capability, and 8 with 22,000 lb. capability
- 20 environmental chambers
- Maximum specimen dimensions: length 6-ft., width 13-in.

Special/Unique Capability:

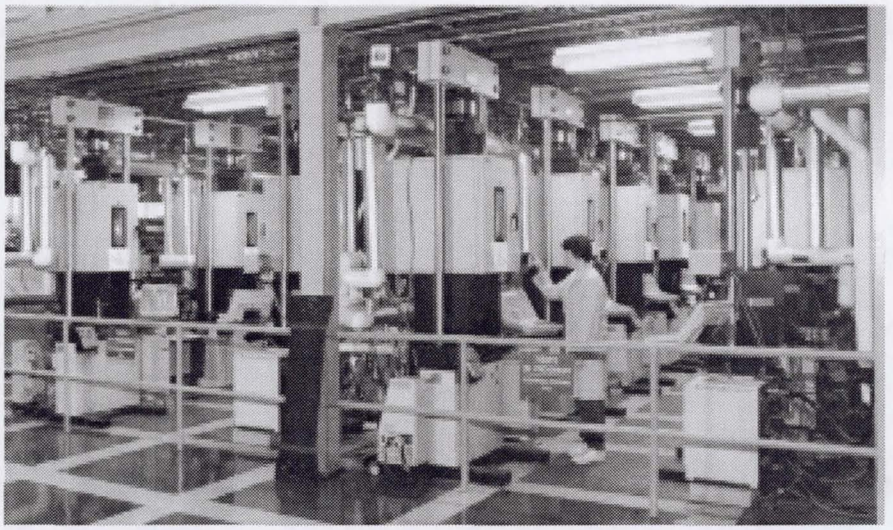
- Chambers and load frames can be programmed to operate independently or concurrently.

Equipment/Instrumentation:

- Digital outputs for load and stroke
- Mechanical grips

Point of Contact:

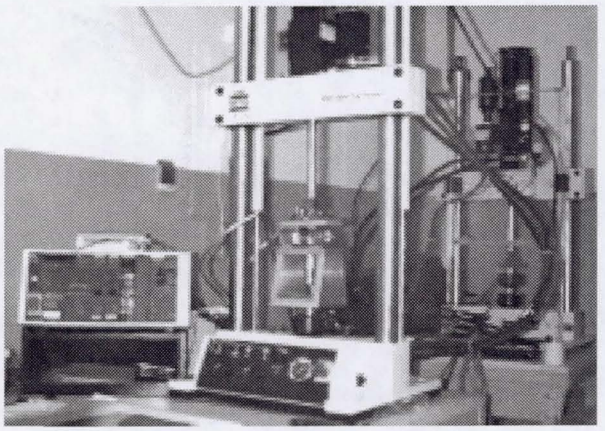
- Materials Research Laboratory, Building 1205. Dr. Thomas S. Gates (757) 864-3400 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173



5-Kip Small Load Material Characterization Equipment

Purpose:

- To experimentally determine the mechanical properties of materials with specimen configurations requiring relatively small loads.



Primary Capabilities:

- Test for mechanical properties of materials using ASTM standards. Test types include 3- and 4- point flex, short beam shear, notched bend, interlaminar fracture toughness.
- 5,000 lb. hydraulic load stand (2 each) 500 pound load cell mounted in series.
- 1,000 lb. screw drive load stand (1 each) 100 lb. and 10 lb. load cells available

Special/Unique Capability:

- Fixtures for 3- and 4- point bend testing and interlaminar fracture testing

Point of Contact:

- Materials Research Laboratory, Building 1205. Dr. T. Kevin O'Brien (757) 864-3465 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173

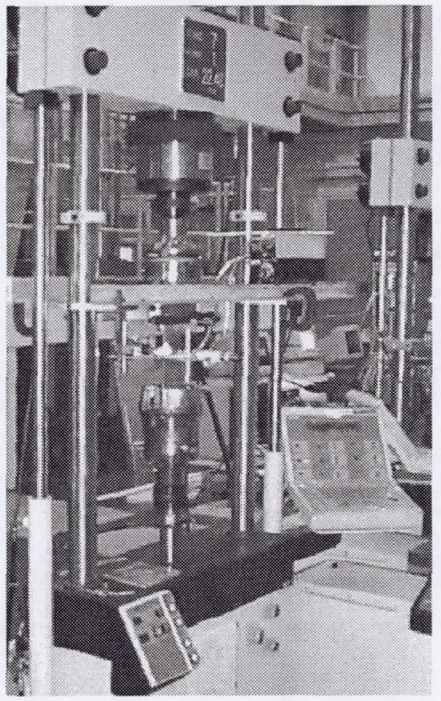
20-Kip Hydraulic Load Test Stands

Purpose:

- To determine the mechanical properties of coupon and structural sub-components.

Primary Capabilities:

- Mechanical loading of moderate size specimens for strength, compliance, and fracture property tests using either standard or custom specimen configurations.
- 20-Kip tension/compression load capacity
- Maximum specimen length: 2 ft.
- Maximum stroke: 6 in.
- Crosshead speed: .002 to 20 in/min
- Column spacing: 26 in.



Special/Unique Capabilities:

- Environmental chambers with temperatures up to 600°F
- Long focal length microscopes (x 5,000)

Equipment/Instrumentation:

- Crack growth measurement apparatus
- Data acquisition: 40 channels @ 2 Hertz
- Hydraulic grips or various custom designed mechanical grips

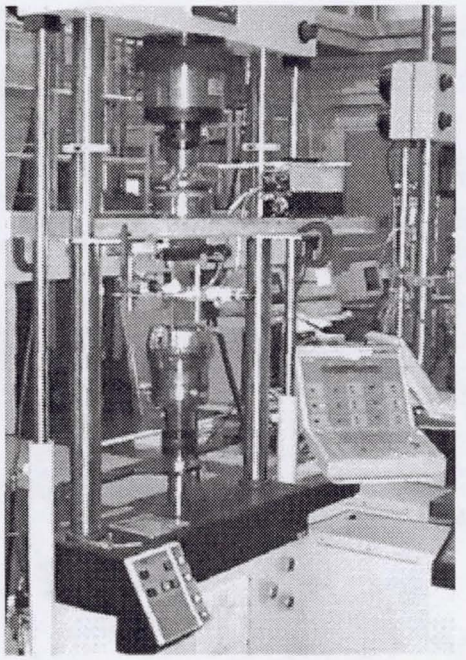
Point of Contact:

- Materials Research Laboratory, Building 1205. Dr. James R. Reeder (757) 864-3456 Branch Head: Dr. Damodar R. Ambur (757) 864-3173

50-Kip Hydraulic Load Test Stands

Purpose:

- To determine the mechanical properties of coupons and structural sub-components.



Primary Capabilities:

- Mechanical loading of moderate-size specimens for strength, compliance, and fracture property tests using either standard or custom specimen configurations.
- 55-Kip tension/compression load capacity
- Maximum specimen length: 2 ft.
- Maximum stroke: 6 in.
- Crosshead speed: .002 to 20 in/min

Special/Unique Capabilities:

- Environmental chambers with temperatures up to 600°F
- Long focal length microscopes (x 5,000)
- Crack growth measurement apparatus
- Data acquisition: 40 channels @ 2 Hertz

Equipment/Instrumentation:

- Column spacing: 26 in.
- Hydraulic grips or various custom designed mechanical grips

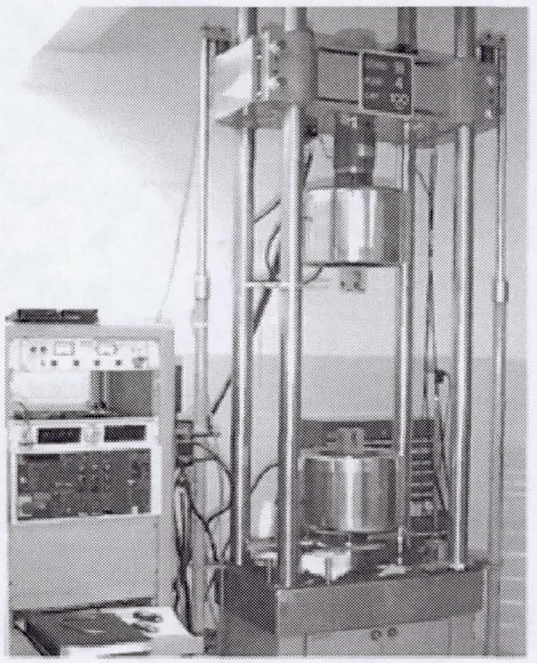
Point of Contact:

- Materials Research Laboratory, Building 1205. Dr. James R. Reeder (757) 864-3456 Branch Head: Dr. Damodar R. Ambur (757) 864-3173

100-Kip Structural Fatigue and Fracture Test Equipment

Purpose:

- To experimentally determine the durability and damage tolerance properties of materials and structural sub-components subjected to mechanical loading conditions.



Primary Capabilities:

- Test for durability and damage tolerance properties of materials using ASTM standards and in-house developed procedures. Test types include crack propagation, fracture toughness, and residual strength of materials and structural concepts.
- 100,000 lb. load capability
- Maximum specimen length: 6ft.
- Test frequency limited only by specimen stiffness

Special/Unique Capability:

- Vacuum and Environmental chambers.

Equipment/Instrumentation:

- Spectrum loading and data acquisition
- 4-inch-wide hydraulic and 24-inch-wide mechanically fastened grips

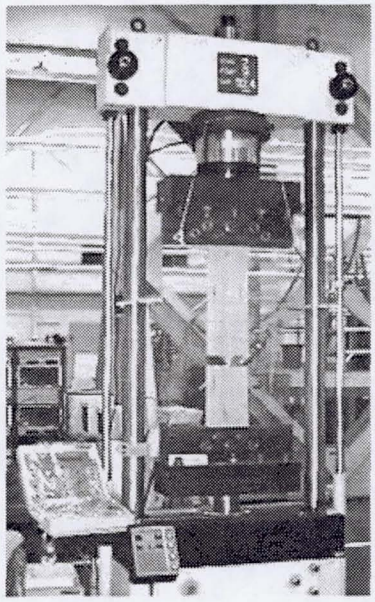
Point of Contact:

- Materials Research Laboratory, Building 1205. Dick Everett (757) 864-3459 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173

100-Kip Fatigue Test Machine /w Mechanical Grips

Purpose:

- To experimentally determine the durability and damage tolerance properties of materials and structural sub-components subjected to mechanical loading conditions.



Primary Capabilities:

- Test for durability and damage tolerance properties of materials using ASTM standards and in-house developed procedures. Test types include crack propagation, fracture toughness, and residual strength of materials and structural sub-components.
- 100,000 lb. load capability
- Maximum specimen length: 3 ft
- Test frequency limited only by specimen stiffness

Special/Unique Capability:

- Vacuum and Environmental chambers

Equipment/Instrumentation:

- Spectrum loading and data acquisition
- 24-inch-wide mechanically fastened grips

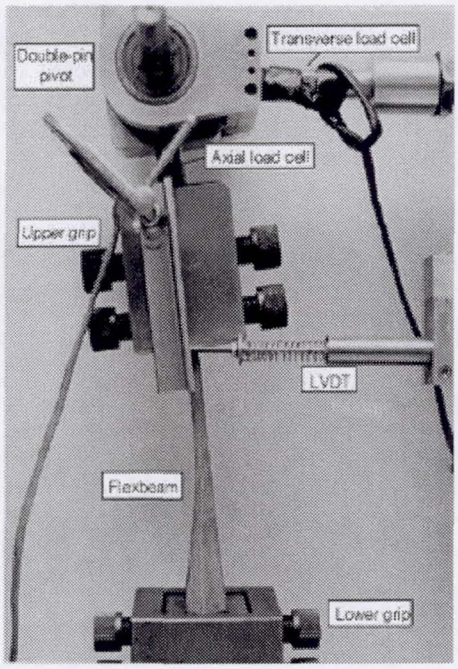
Point of Contact:

- Materials Research Laboratory, Building 1205. Dick Everett (757) 864-3459 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173

Axial Tension and Bending (ATB) Test Stand

Purpose:

- To experimentally determine the strength and life of specimens subjected to combined tension and bending loads



Primary Capabilities:

- Test for strength and life under combined axial tension and fully reversed bending loads applied at one end with the other end clamped.
- 10,000 pound axial load cell

Special/Unique Capability:

- 2000 pound transverse load cell

Equipment/Instrumentation:

- Instrumented upper grip with axial load cell

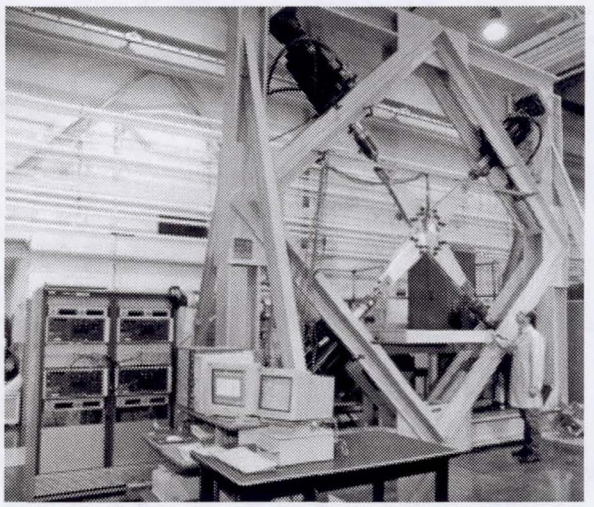
Point of Contact:

- Materials Research Laboratory, Building 1205. Dr. T. Kevin O'Brien (757) 864-3465 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173

Biaxial Tension Load Frame

Purpose:

- To experimentally evaluate the behavior of materials and structural sub-components subjected to biaxial tension loading conditions.



Primary Capabilities:

- Biaxial yield surface and fracture tests of metallic and composite materials.
- 225,000 lb. major axis load capacity
- 165,000 lb. minor axis load capacity
- Maximum specimen length: 4 ft.

Special/Unique Capabilities:

- Four independent servohydraulic rams capable of biaxial tension loading of specimens with up to a 3 ft. diameter gage section.
- Cryogenic (LN_2) environment

Equipment/Instrumentation:

- 100 channel data acquisition system

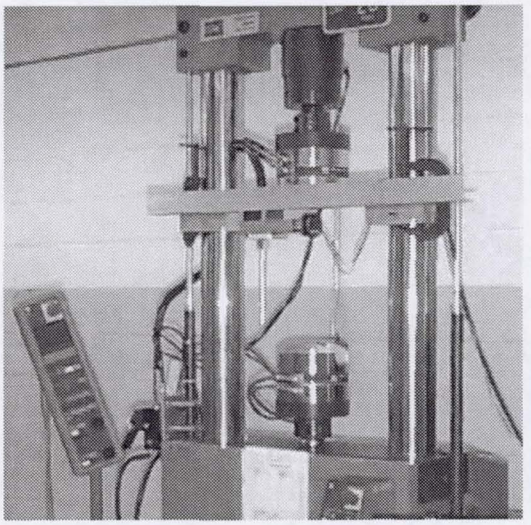
Point of Contact:

- Materials Research Laboratory, Building 1205. John A. Wagner (757) 864-3132 or Branch Head: Dr. Damodar Ambur (757) 864-3173

Tension-Torsion Test Machine

Purpose:

- To experimentally determine the mechanical properties of materials subjected to combined axial and torsion loading.



Primary Capabilities:

- Test for mechanical properties of materials under axial and/or torsion loading. Test types include static, fracture and fatigue tests.
- 20,000 lb axial load capability.
- 10,000 in.-lb torque load capability.
- Maximum axial displacement: 5-in.
- Maximum torsion angle :±50°

Special/Unique Capability:

- Can be programmed to apply any combination of axial and torsion control modes

Equipment/Instrumentation:

- 4 digitally recorded channels
- Hydraulic grips

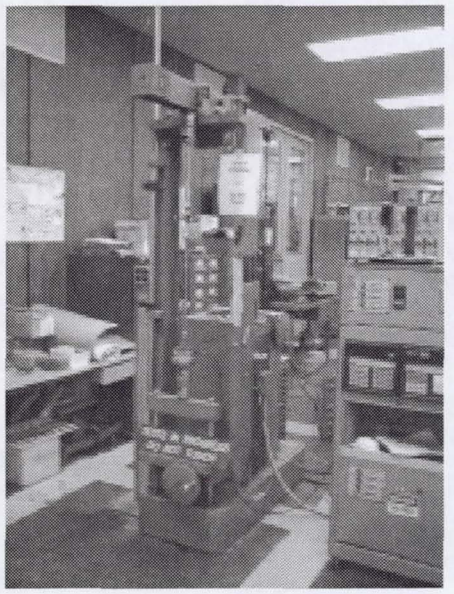
Point of Contact:

- Materials Research Laboratory, Building 1205. Dr.Tzikang Chen (757) 864-3470 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173

Constant Load Creep Frames

Purpose:

- To experimentally determine creep properties of materials under constant load and elevated temperatures for long durations.



Primary Capabilities:

- Perform creep tests on foil or sheet gage specimens or 0.5 inch diameter round specimens. Constant dead-weight load frames are equipped with either ovens or furnaces which can be changed to ensure steady temperature control over long duration tests. Variety of strain measurement devices with resolution and stability for measuring small strain changes over long periods of time.

Special/Unique Capability:

- Ability to perform creep tests in air at temperatures up to 2000°F
- Specially designed counter-balanced extensometer can be attached to thin gage specimens to measure strains without requiring the specimen to carry the load of the extensometer.

Equipment/Instrumentation:

- Ten dual-ratio (3:1 and 20:1 lever arms) creep frames
- Loads from 5 lbs. to 12,000 lbs.
- Five box ovens with circulating fans; maximum temperatures 800°F to 1100°F
- Seven ceramic radiant three-zone furnaces; maximum temperature 2200°F
- Dedicated System 4000 computer data acquisition system

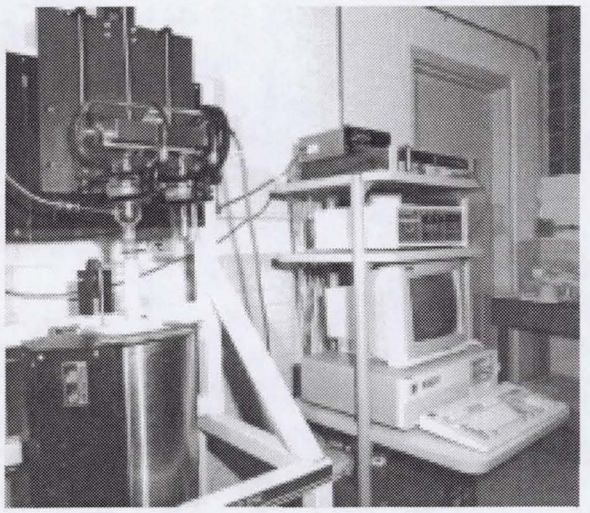
Point of Contact:

- Materials Research Laboratory, Building 1205. Karen Taminger, (757) 864-3131 or Branch Head Dr. Stephen J. Scotti (757) 864-5431

Thermogravimetric Analysis Equipment

Purpose:

- To experimentally determine the oxidation rates of materials at elevated temperatures



Primary Capabilities:

- Measures weight change of samples suspended into tubular furnace. Atmosphere is controlled by flow of high-purity gas, usually air, through furnace.

Special/Unique Capability:

- Furnace with temperature range up to 1200°C

Equipment/Instrumentation:

- Cahn C2000 Microbalance with 0.1μm sensitivity
- Mass flow controllers regulate gas flow through furnace
- Data acquisition records sample weight change and test parameters

Point of Contact:

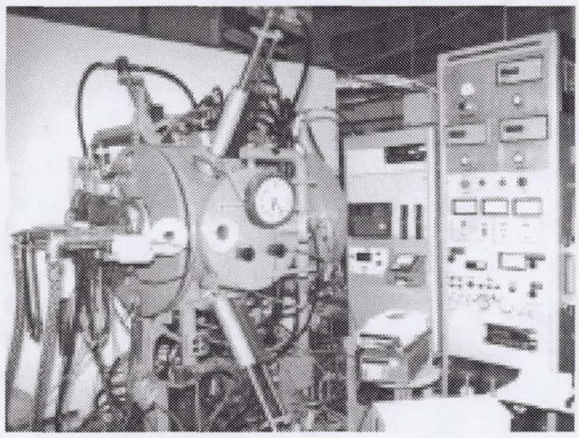
- Materials Research Laboratory, Building 1205. Terryl Wallace (757) 864-3511 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Hypersonic Materials Environmental Test System (HYMETS)

Purpose:

- To evaluate response of materials and coatings to hypersonic air flows

Primary Capabilities:



- 100-kW constrictor-arc-heated hypersonic wind tunnel that uses air plus nitrogen and oxygen in ratios equivalent to air. The flow impinges on test sample mounted in a stagnation configuration. The range of test conditions are as follows:
- Specimen: 1 inch diameter stagnation
- Spec. Temp, °C (°F) 800-1500 (1472-2732)
- Surface Pressure, Pa 400-800
- Free Stream Enthalpy, MJ/kg 4-11
- Free Stream Mach no. 3.5-5.0
- Cold wall heating rate, kW/m^2 80-450

Special/Unique Capability:

- Small specimen size allows cost effective technique for evaluation of coatings and materials performance

Equipment/Instrumentation:

- Data acquisition system to record test parameters and specimen temperature
- Reflectometer to measure spectral emittance of samples

Point of Contact:

- Materials Research Laboratory, Building 1205. Terryl Wallace (757) 864-3511 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Cambridge Stereoscan 240 Scanning Electron Microscope

Purpose:

- Used for fractographic examination of various types of fractured and failed surfaces.

Primary Capability:

- Fractographic analysis of multiple types of specimens including, metallic fatigue crack growth fracture surfaces, composite fracture and failure surfaces, and acetate replicas.
- 10 angstrom resolution under proper conditions.

Special/Unique Capabilities:

- Can handle large specimens at long working distances since it has a large 12" X 12" specimen chamber.
- LaB_6 filaments can be used for increased resolution.

Point of Contact:

- Materials Research Laboratory, Building 1205. Dr. James C. Newman, Jr. (757) 864-3487 or Branch Head: Dr. Damodar R. Ambur (757) 864-3173

Light Alloy Laboratory
(Bldg 1205)

Hot Isostatic Press

Purpose:

- Fabrication of powder metallurgy compacts and metal matrix composites for development and optimization of material processing routes for advanced temperature-resistant metallic materials

Primary Capabilities:

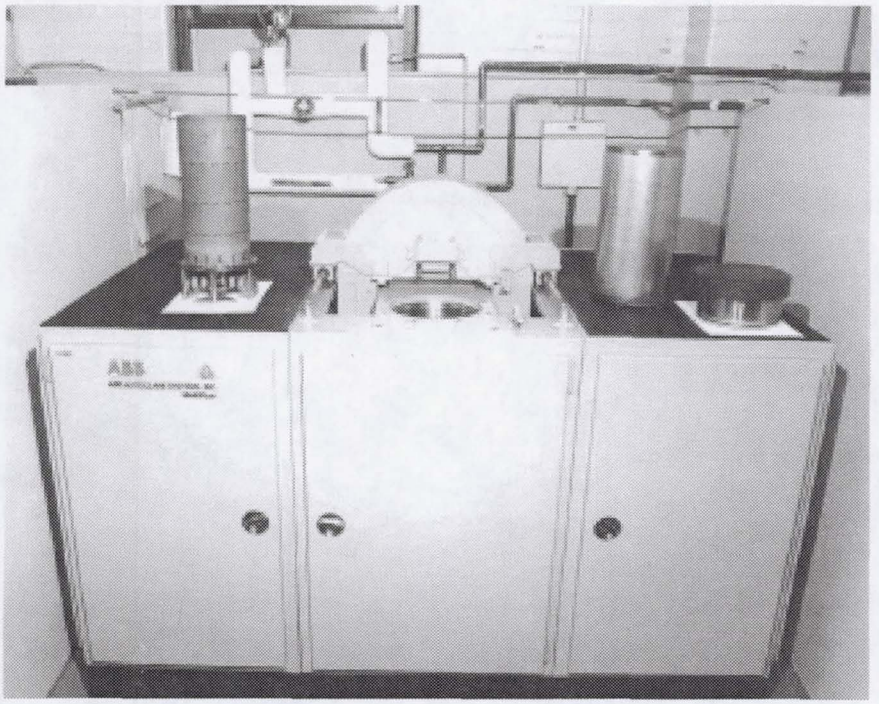
- Consolidation of powder metallurgy compacts and fiber-reinforced metal matrix composites at high temperature and pressure in vacuum environment

Equipment/Instrumentation:

- 30,000-psi isostatic pressure system (argon gas)
- 2300°F temperature capability
- Specimen sizes up to 5 inches in diameter and 10 inches tall
- Programmable automated time-temperature-pressure control

Point of Contact:

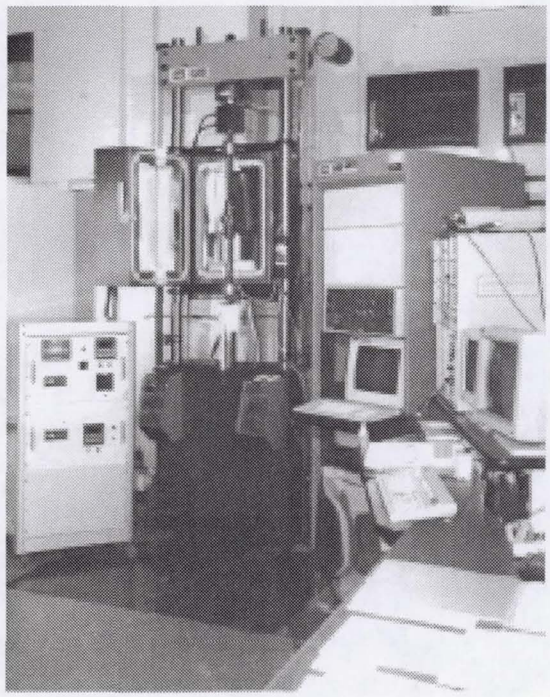
- Light Alloy Laboratory, Building 1205. R. Keith Bird (757) 864-3512 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431



Mechanical Property Characterization Equipment

Purpose:

- Experimentally determine mechanical properties of materials



Primary Capabilities:

- Test for mechanical properties of materials using ASTM standards. Test types include tension, compression, fatigue, fracture toughness, etc.

Special/Unique Capability:

- Various chambers, grips, and extensometry to allow testing at temperatures ranging from -320°F (liquid N_2) to 2200°F

Equipment/Instrumentation:

- Two test systems
- 22,000-lb load capacity
- Hydraulic and pin-loaded grips
- Programmable test control system
- Automated 50-channel data acquisition

Point of Contact:

- Light Alloy Laboratory, Building 1205. R. Keith Bird (757) 864-3512 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Wilson Rockwell Series 2000 Hardness Tester

Purpose:

- To determine hardness of most metals and alloys, ranging from the softest bearing materials to the hardest steels

Primary Capabilities:

- Measuring hardness of aluminum and titanium alloys in various tempers
- Monitoring hardness changes during precipitation hardening of aluminum alloys

Equipment/Instrumentation:

- Computer-controlled operation, room temperature testing
- Standard hardness scales: 'A' through 'V' using steel ball or diamond indenter
- Superficial hardness scales: '15N' through '45Y' using diamond or steel ball indenter
- Various anvil types designed to support different shapes of work pieces

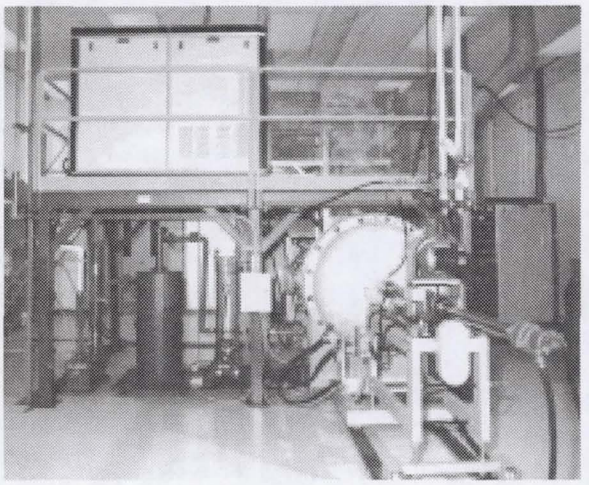
Point of Contact:

- Light Alloy Laboratory, Building 1205. Anton Schuszler II (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Low Pressure R.F. Inductively Coupled Plasma Spray Deposition Equipment

Purpose:

- High purity processing of near net shape structures, coatings, engineered materials, smart materials.



Primary Capabilities:

- High purity processing of high temperature materials.
- Metal Matrix Composites (MMC) from powder metal alloys.
- Thin and thick foils of various alloys.
- Built up near net shape structures.
- Thermal exposure in low pressure/inert enviroment.
- Deposit wear resistant, abrasive, thermal and environmental protective coatings

Special/Unique Capability:

- Electrodeless processing for extremely clean fabrication of advanced high temperature materials at low pressure in an inert environment.

Equipment/Instrumentation:

- 240 KVA System.
- Vacuum chamber size 3 feet diameter by 3 feet length .
- PLC controlled target manipulator.
- Manipulator can be rotational/translational, or X/Y table for flat target.
- Dual powder feeder.
- Oil scrubber for particulate hazards.
- Hydro-static precipator.
- System employs electronic mass flow gas meters.
- System utilizes argon, helium, and hydrogen gases.
- Water cooled target capability.

Point of Contact:

- Light Alloy Laboratory, Building 1205. Dr. Stephen Hales (757) 864-3128 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Vacuum Hot Press

Purpose:

- Fabrication of metal matrix composites for development and optimization of material processing routes for advanced temperature-resistant metallic materials

Primary Capabilities:

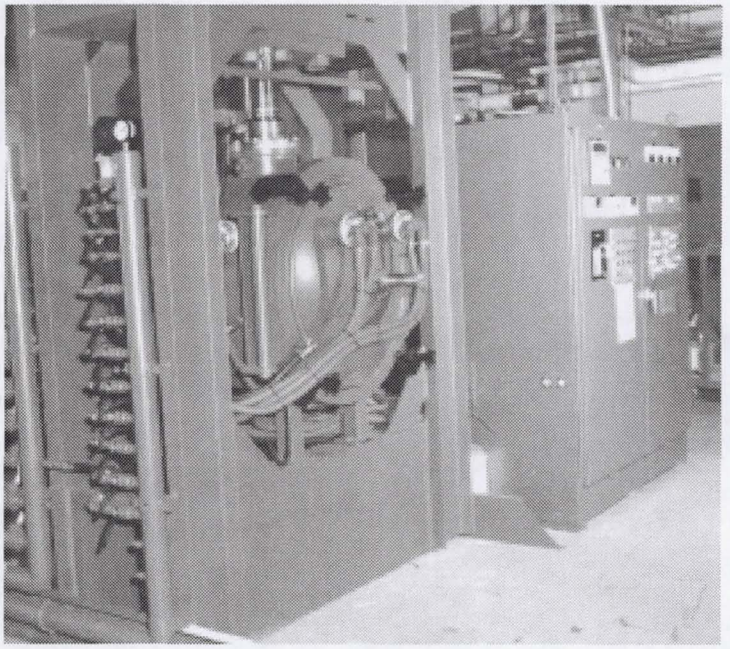
- Consolidation of fiber-reinforced metal matrix composites at high temperature and pressure in vacuum environment

Equipment/Instrumentation:

- 100-ton capacity compressive load frame
- 10^{-6} torr vacuum chamber
- 2200°F temperature capability
- Specimen sizes up to 12 inches in diameter
- Programmable automated time-temperature-pressure control

Point of Contact:

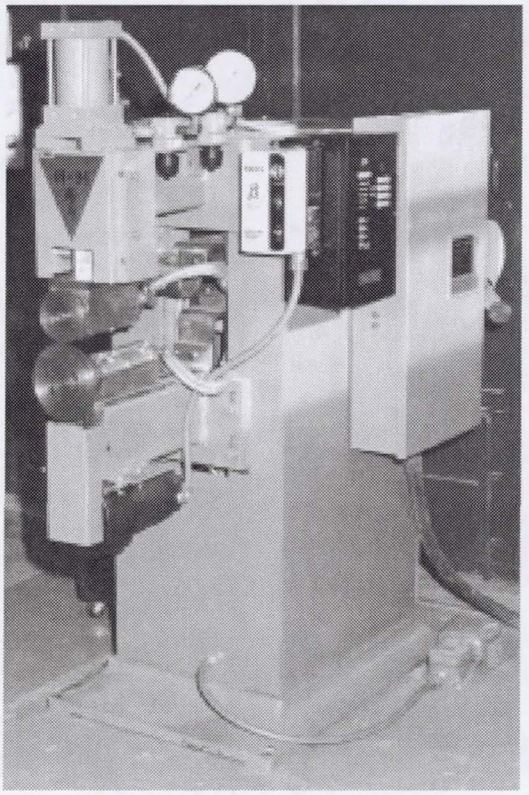
- Light Alloy Laboratory, Building 1205. R. Keith Bird (757) 864-3512 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431



Resistance Seam Welder

Purpose:

- Fabrication of air-tight bags to allow hot isostatic pressing of fiber-reinforced metal matrix composites to facilitate material processing optimization or heat treatment of materials in inert/vacuum environments



Primary Capabilities:

- Seam welding of stainless steel and titanium bags for hot isostatic press system, heat treatments, and removal of volatiles from materials via hot outgassing

Equipment/Instrumentation:

- 440 volts
- 125 amps
- Programmable weld schedule controller
- 18-inch throat depth
- 6-inch diameter drive wheel with variable speed circular drive
- 4-inch diameter electrode wheel
- Weld thickness range of 0.001 inch to 0.040 inch

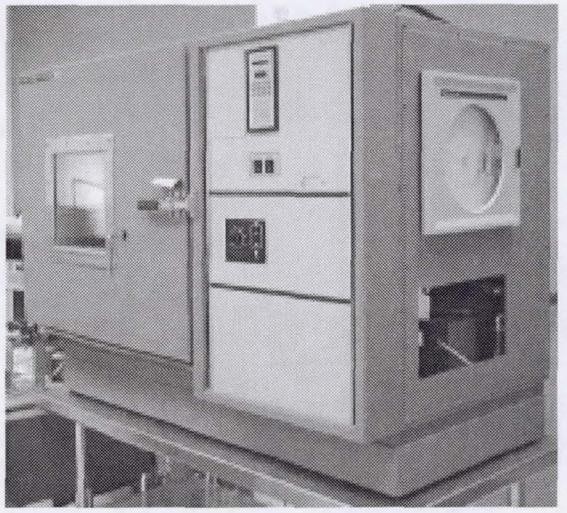
Point of Contact:

- Light Alloy Laboratory, Building 1205. Anton Schuszler II, (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Temperature-Humidity Test Chamber

Purpose:

- To provide exposure of materials to controlled temperature and humidity conditions.



Primary Capabilities:

- Supports exposure of materials to constant temperature-humidity conditions or to programmed cyclic temperature and humidity profiles. Accommodates a wide range of test articles, up to 15" in width or height. Self-stressing apparatus may be included within the exposure chamber. Insulated instrumentation port allows continuous monitoring of specimen instrumentation.

Special/Unique Capabilities:

- Environmental chamber with 20" x 20" x 24" interior cabinet.
- Temperature range: -20 to 350°F
- Humidity range: 20% to 95%
- Programmable controller to define temperature-humidity profiles.
- Instrumentation port for external monitoring and/or recording of specimen instrumentation.
- Closed-loop water re-circulation system with 5 gallon capacity.

Equipment/Instrumentation:

- Programmable controller
- Continuous temperature-humidity record

Point of Contact:

- Light Alloy Laboratory, Building 1205. Marcia Domack (757) 864-3126 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Aqueous Corrosion Test Facility

Purpose:

- To determine the corrosion performance of metallic materials exposed to aqueous environments.

Primary Capabilities:

- Provides continuous and alternate immersion exposure of metallic materials to aqueous corrosion environments. Facility accommodates a wide range of specimen configurations exposed in both stressed and unstressed conditions.

Special/Unique Capabilities:

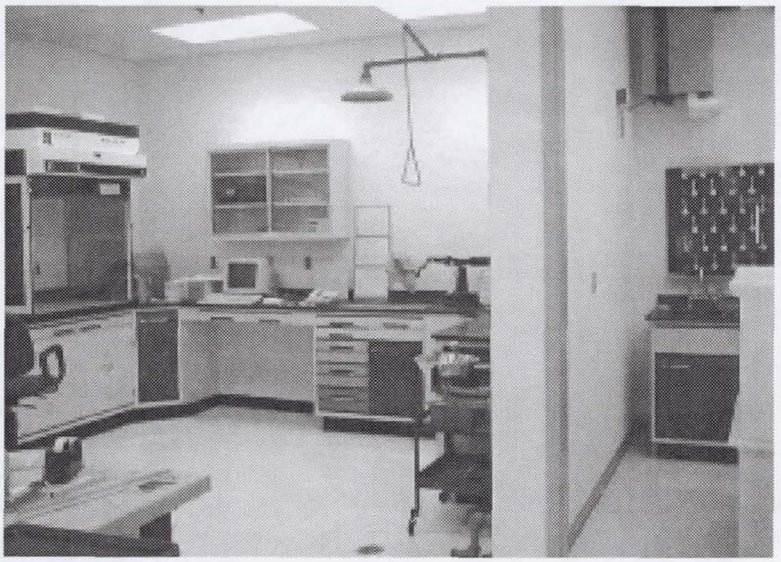
- Two exposure tanks with 36" x 24" x 18" interior capacity.
- Rotating carousel supports up to 30 1"-square specimens.
- 12' x 6' temperature/humidity controlled room.
- Supports ASTM test methods G44, G34, and G110.
- Supports ASTM test specimens G38, G49, G58, G30, and G39.

Equipment/Instrumentation:

- Continuous temperature-humidity record.

Point of Contact:

- Light Alloy Laboratory, Building 1205. Marcia Domack (757) 864-3126 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431



Metallography Laboratory

Purpose:

- To support microstructural evaluation of materials.

Primary Capabilities:

- Sectioning, mounting, polishing and etching of materials including polymers, composites, metallics and refractories. Both transmitted and reflected light microscopy up to 1000X magnification. Stereomicroscopy and macrophotography.

Special/Unique Capability:

- Anodic etching of aluminum alloys. Electropolishing of aluminum alloys. High magnification (up to 1000X) photomicroscopy capability with the following optical microscopy techniques; brightfield, darkfield, polarized, and Differential Interference Contrast (DIC, Nomarski).

Equipment/ Instrumentation:

- Large number of cutting machines including both low and high-speed machines which can use, diamond, aluminum oxide, and silicon oxide cut–off wheels. Ability to cold-mount materials. Automated polishing machines. Leica MeF3 and MeF4 metallographs. Leica Ortholux-Pol for transmitted light investigations. Polaroid MP-4 and Leica makroscope for macrophotography.

Point of Contact:

- Light Alloy Laboratory, Building 1205. Anton Schuszler II, (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Electron Microscopy Sample Prep Laboratory

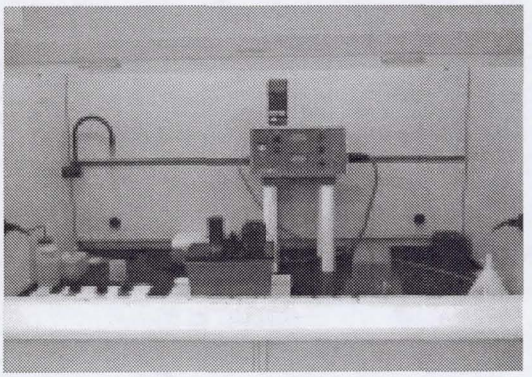
Purpose:
- Preparation of electron transparent thin foils for TEM analysis.

Primary Capabilities:
- Mechanical thinning, dimpling, electropolishing and ion milling.

Special/Unique Capability:
- Tripod polishing of non-conductive samples.

Equipment/Instrumentation:
- Struers twin-jet electropolisher, Tenupol-3
- Gatan Duo-mill ion mill
- VCR Group dimpler
- South Bay Technology Wire saw, slurry drill, 3mm disc punch.

Point of Contact:
- Light Alloy Laboratory, Building 1205. Anton Schuszler II, (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431



JEOL JSM 6400 Scanning Electron Microscope

Purpose:

- Microscopic examination of samples at magnifications ranging from 20X to 40,000X.

Primary Capabilities:

- Surface topography, fractography, channeling contrast micrographs of polished samples, microchemistry.

Special/Unique Capability:

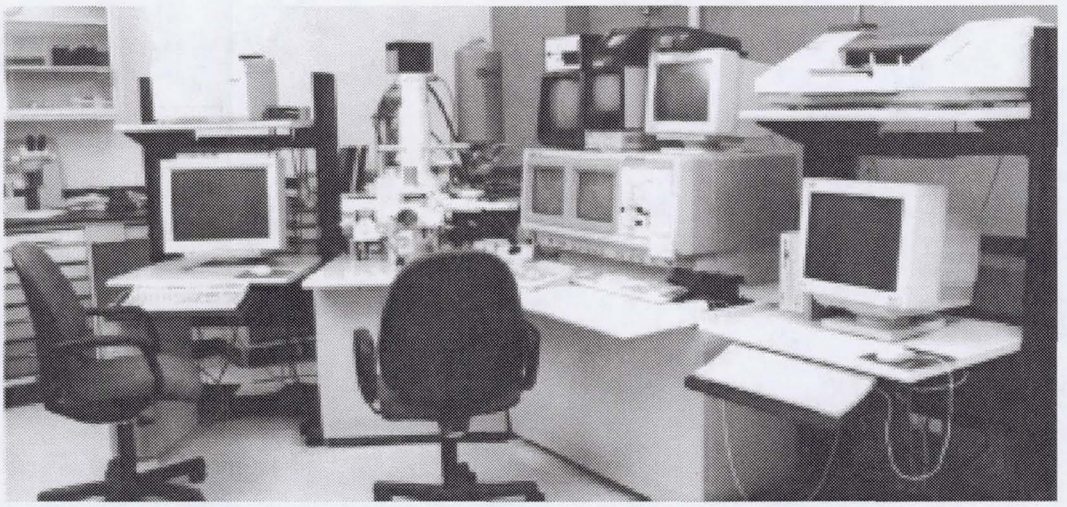
- Microtexture of polycrystalline samples. Spatially-resolved diffraction data is used for the production of orientation images, grain boundary maps and local representations of crystallographic texture.

Equipment/Instrumentation:

- High vacuum gun for LaB_6 filament, secondary and back-scattered electron detectors, analog to digital converters for digital image storage, linked to network. Microtexture system consisting of phosphor screen and optically coupled low light, ccd diffraction camera, image processor, frame grabber and computer hardware and software. EDAX EDS system for chemical analysis and element mapping.

Point of Contact:

- Light Alloy Laboratory, Building 1205. Anton Schuszler II, (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431



JEOL JSM 840A Scanning Electron Microscope

Purpose:

- Microscopic examination of samples at magnifications ranging from 20X to 40,000X.

Primary Capabilities:

- Surface topography, fractography, channeling contrast micrographs of polished samples, microchemistry.

Special/Unique Capability:

- Microanalysis of polycrystalline samples using Wave-length Dispersive Spectrometry (WDS). Light element analysis is included in the WDS capability. Fast x-ray maps using Energy Dispersive Spectrometry (EDS) can be produced to show chemical micro-distributions.

Equipment/Instrumentation:

- High vacuum gun for LaB_6 filament, secondary and back-scattered electron detectors, analog to digital converters for digital image storage. KEVEX EDS/WDS system for chemical analysis and elemental mapping.

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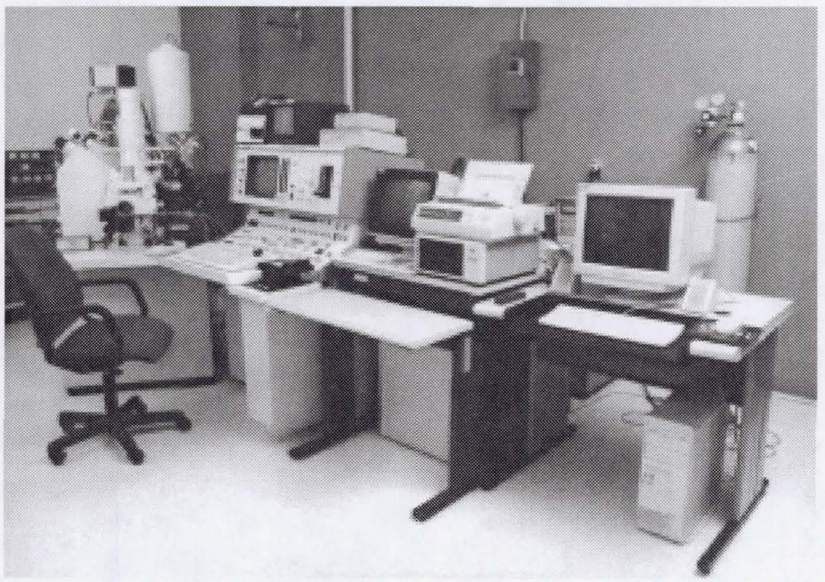

Philips CM200 Transmission Electron Microscope (TEM)

Purpose:

- Examination of electron transparent, 3mm diameter foils at magnifications from ~ 2,000X to 2,000,000X. High resolution imaging, microchemistry, electron diffraction.

Primary Capabilities:

- Continuously variable accelerating voltage to 200kV.
- Microchemistry via Energy Dispersive Spectrometry (EDS) and Electron Energy Loss Spectrometry (EELS).
- Resolution of better than 0.20 nm point-to-point.

Special/Unique Capability:

- Electron energy loss filtered imaging for element-specific (for Z >2) or chemical bond-sensitive maps with a spatial resolution in the nanometer range

Equipment/Instrumentation:

- SuperTWIN objective lens, STEM (Scanning TEM) unit, EDAX ultra thin window EDS detector
  and a Gatan Imaging Filter (GIF) with a Peltier-cooled CCD camera. Digital imaging and EDS system networked

Point of Contact:

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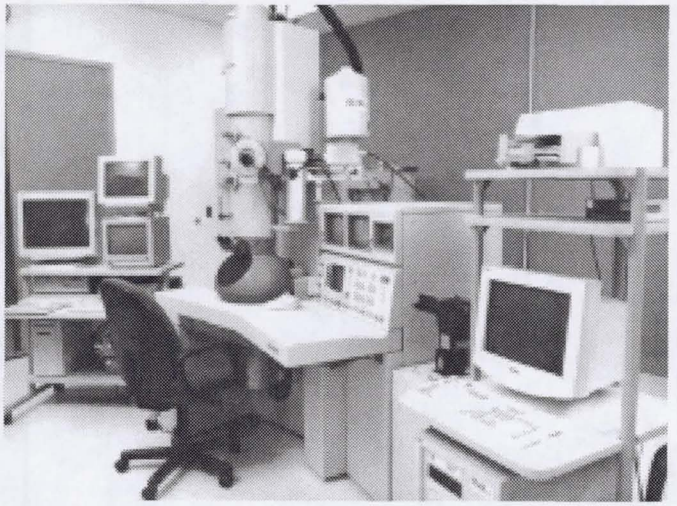
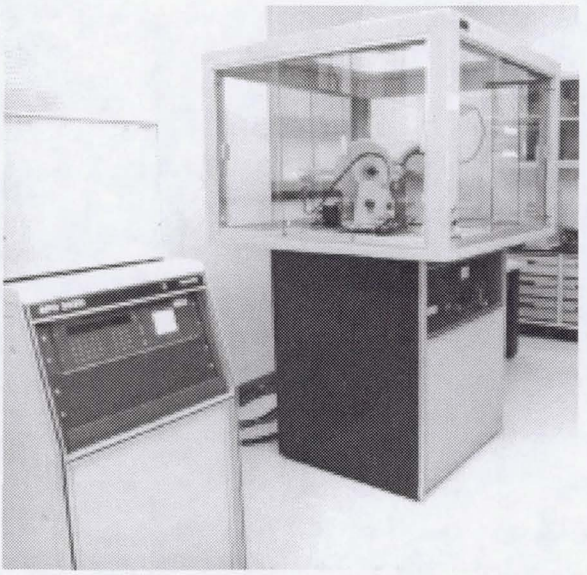


Philips APD-3600-01 X-ray Diffractometer

Purpose:

- To perform detailed crystallographic evaluation of materials using a variety of unique x-ray diffraction techniques.



Primary Capabilities:

- Scintillation detector for standard powder diffraction scans with good resolution. Software includes routines for peak deconvolution, fitting, and search/match peak identification.
- Schultz device and software for determining pole figures and Orientation Distribution Function (ODF) texture analysis on cubic material systems.
- Two independent systems housed within a common radiation safety enclosure.

Special/Unique Capability:

- Kratky camera for low angle scattering measurements.

Equipment/Instrumentation:

- Two θ-2 θ vertical goniometers with scintillation or proportional detectors
- Schultz device for texture measurements
- Kratky camera for low angle scattering measurements
- Multiple-port Cu radiation sources
- Diffracted beam monochromator on powder goniometer

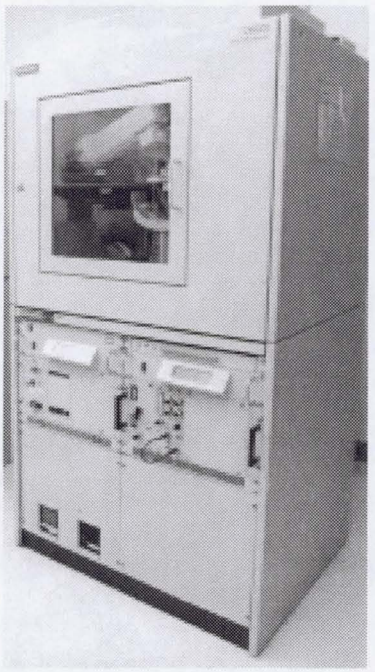
Point of Contact:

- Light Alloy Laboratory, Building 1205. Anton Schuszler II, (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Siemens D5000 X-Ray Diffractometers

Purpose:

- To perform detailed crystallographic evaluation of materials using a variety of unique x-ray diffraction techniques.



Primary Capabilities:

- θ-θ vertical goniometer has a rotating, horizontal sample stage and position sensitive detector for rapid high quality data collection with good resolution. Software includes routines for peak deconvolusion, fitting, and search/match peak identification.
- θ -2θ horizontal goniometer with a scintillation detector has an open Eulerian cradle and software for determining residual stresses, pole figures, and ODF texture analysis.

Special/Unique Capability:

- This laboratory is equipped with a wide range of attachments and software, which in combination with the modular design of these two goniometers allows reconfiguration of these systems for performing a large variety of unique x-ray diffraction experiments. Unique capabilities include reflectometry, elevated temperature stage with ion vacuum pump, high resolution monochromatic beam. The configurations typically used in this lab are also fairly unique for x-ray diffraction.

Equipment/Instrumentation:

- θ - θ vertical goniometer with position sensitive detector
- θ - 2θ horizontal goniometer with scintillation detector
- High temperature stage (up to 1600°C) with ion vacuum pump
- Open Eulerian cradle with ϕ - rotation & x-translation
- Rotating sample stage
- Radiation sources : Cu, Cr, Mo
- Incident & diffracted beam monochromators

Point of Contact:

- Light Alloy Laboratory, Building 1205. Karen Taminger (757) 864-3131 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Philips EM 420T Transmission Electron Microscope (TEM)

Purpose:

- Analytical electron microscope used in the micro- and nano-structural characterization of advanced materials

Primary Capabilities:

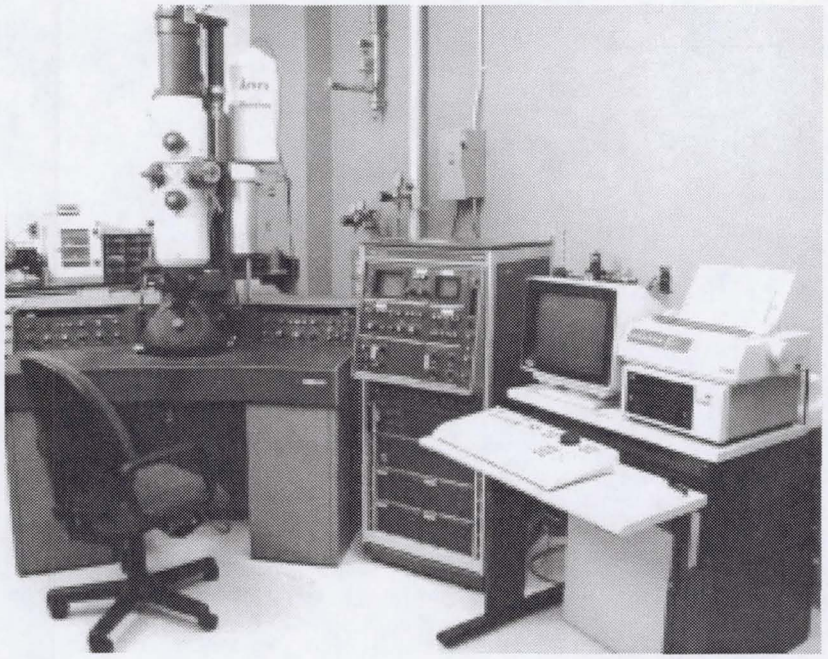
- Bright-field and dark-field imaging
- Selected area diffraction
- Convergent beam electron diffraction
- Chemical analysis using x-rays
- Scanning Transmission Electron Microscopy (STEM)

Special/Unique Capabilities:

- 120kV electron source
- Energy dispersive x-ray spectrometry
- STEM

Point of Contact:

- Light Alloy Laboratory, Building 1205. Anton Schuszler II (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431



TA Instruments 1600 Differential Thermal Analyzer

Purpose:

- To determine the temperature of phase transitions in solids

Primary Capabilities:

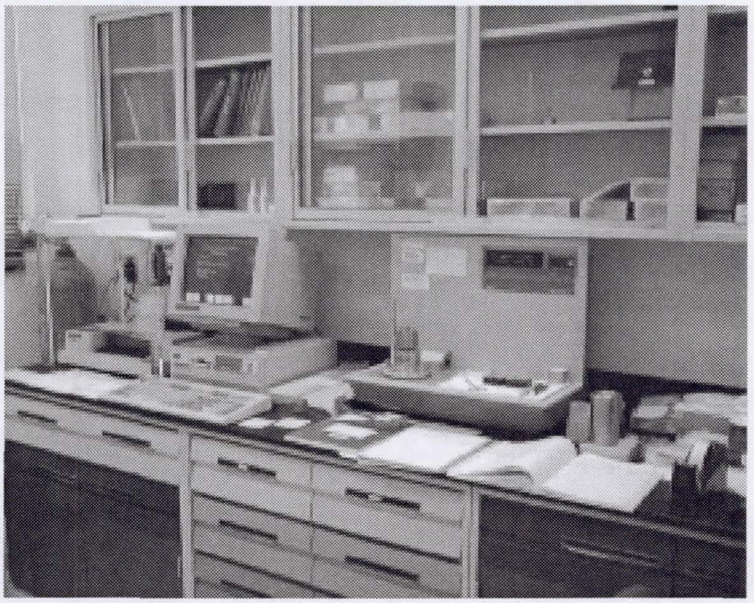
- To monitor endothermic and/or exothermic processes involved with physical processes, such as glass transition temperature in glasses and ceramics, precipitation or dissolution of second phase particles in metallic systems, melting in solids

Equipment/Instrumentation:

- Computer-controlled operation
- Temperature range: RT to 1600°C
- Scanning rate during heating: variable
- Sample size: $75mm^3$
- ΔT Senstitivity: 0.001°C
- Temperature precision: ±2°C
- Atmosphere: static or controlled flow with the inert or reactive gas or air

Point of Contact:

- Light Alloy Laboratory, Building 1205. Anton Schuszler II (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431



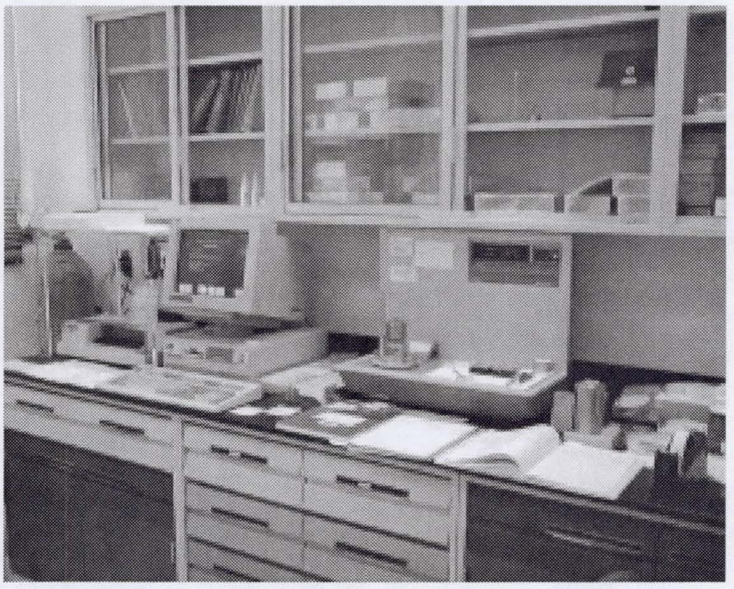
TA Instruments 2910 Differential Scanning Calorimeter

Purpose:
- To determine the temperature and heat flow associated with material transitions

Primary Capabilities:
- To monitor endothermic and/or exothermic processes involved during physical transitions such as melting, phase transformations, recovery and recrystallization
- To determine specific heat as a function of temperature
- To study kinetics of solid state transformations

Equipment/Instrumentation:
- Computer-controlled operation and electronic data archival
- Temperature range: RT to 725°C
- Scanning rate during heating: variable in the range of 0.5°C/min to 100°C/min
- Sample size: 5 to 100 mg, 5mm diameter (max)
- Use of inert atmospheres
- Calorimetric sensitivity: 3μw (RMS)
- Temperature repeatability: ±0.1°C

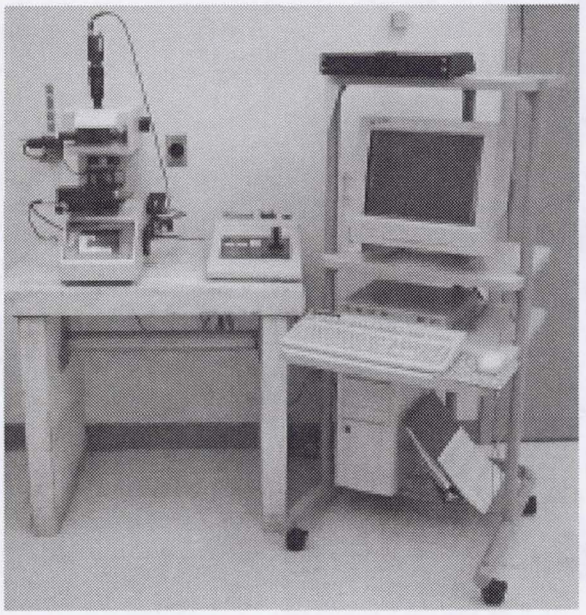
Point of Contact:
- Light Alloy Laboratory, Building 1205. Anton Schuszler II (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431



Buehler Omnimet Microhardness Tester

Purpose:

- To conduct static indentation tests on metallic alloys, metal-matrix composites, and structures coated with wear-resistant coatings, in accordance with ASTM E384



Primary Capabilities:

- Measuring hardness of precision work pieces in various product forms that are too thin or too small in diameter to be measured by conventional macroscopic methods
- Measuring hardness of surface layers such as plating, case depths in carburized or nitrided components, oxygen-contamination depths in oxided titanium alloys
- Measuring hardness of individual micro-constituents

Special/Unique Capability:

- Automatic mode of measurement enables creation of custom patterns of indentations

Equipment/Instrumentation:

- Windows 95-based, with computer-controlled specimen stage, indenter turret system and autofocusing capability
- Load range: 1, 5, 10, 50, 100, 300, 500, 2000 gf
- X and Y traverse: ±25mm each
- Vickers and Knoop indenters
- CCD camera with objective lenses of 10x and 40x
- Electronic filing of microhardness data

Point of Contact:

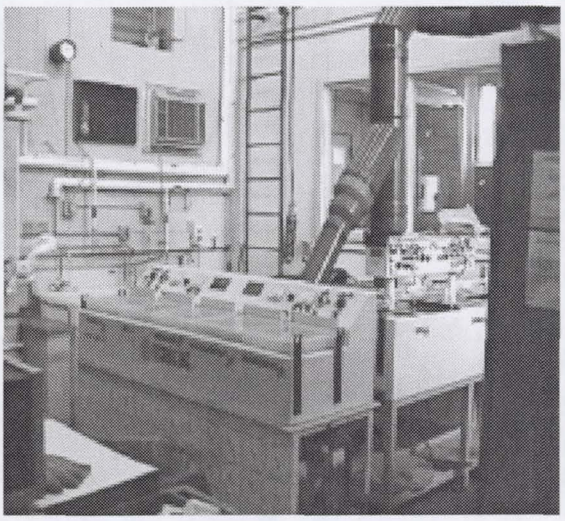
- Light Alloy Laboratory, Building 1205. Anton Schuszler II (757) 864-3145 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Metals Cleaning Laboratory
(Bldg 1229A)

Metals Cleaning Laboratory

Purpose:

- Performs chemical and electro-chemical surface preparations for metallic materials including cleaning, etching, milling, passivating, polishing, plating, and anodizing in support of center-wide research activities



Primary Capabilities:

- Specimen and small component surface preparation; larger components can be serviced on a limited basis
- Surface preparation techniques include chemical cleaning, etching, milling, electroplating, passivating, polishing, anodizing, and Iridite conversion coatings.
- Plating capabilities include the application of copper, gold, silver, indium, nickel, and platinum for dimensional change or protection purposes

Special/Unique Capabilities:

- Surface preparation techniques for a wide range of materials including alloys of aluminum, titanium, copper, nickel, iron, and tantalum; steels and stainless steels; and specialty products such as Inconel and Vascomax.
- Maximum specimen size is limited by tank size; call for further information
- Surface preparation service "house calls" are available to your facility, reducing down time and saving expensive breakdown labor

Equipment/Instrumentation:

- Brush and tank plating capabilities
- Iridite conversion coatings tanks
- Chemical etching, milling, and cleaning tanks
- Anodizing facilities

Point of Contact:

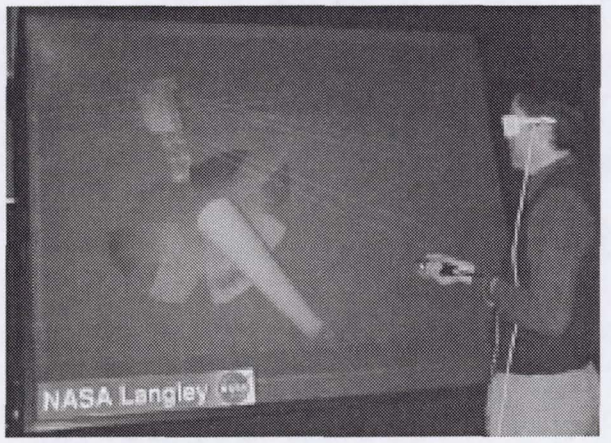
- Metals Cleaning Laboratory, Building 1229A. Eric K. Hoffman (757) 864-3127 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Immersive Design And Simulation Laboratory (Bldg 1229)

Immersive Design and Simulation Lab

Purpose:

- To provide a testbed for the development and demonstration of 3D immersive design and simulation tools.



Primary Capabilities:

- High-performance multi-processor, computing.
- Large, single-screen display of 3D stereoscopic images.
- Head tracking for semi-immersive virtual reality.

Equipment/Instrumentation:

- Pyramid Systems ImmersaDesk™ 2 Projection VR system
  - 4' x 5' screen
  - high-resolution projector
- SGI Onyx2 supercomputer
  - Eight R10000 (250MHz) processors
  - 14 GB shared memory
  - Infinite Reality™ graphics engine (13.1 polygons/sec, 192M pixelfill/sec, 64MB texture memory)
- Head and wand tracking
- Stereoscopic shutter glasses

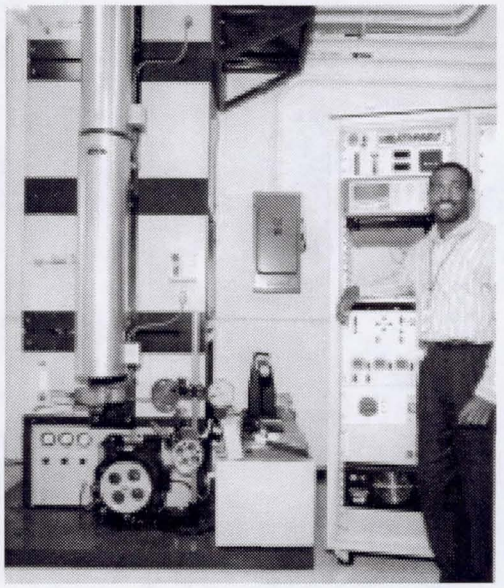
Point of Contact:

- Immersive Design and Simulation Laboratory, Building 1229. Chris Sandridge (757) 864-2816 or Branch Head: Dr. Ivatury S. Raju (757) 864-9272

Nondestructive Evaluation Laboratory (Bldg 1230)

Fiber Optic Draw Tower

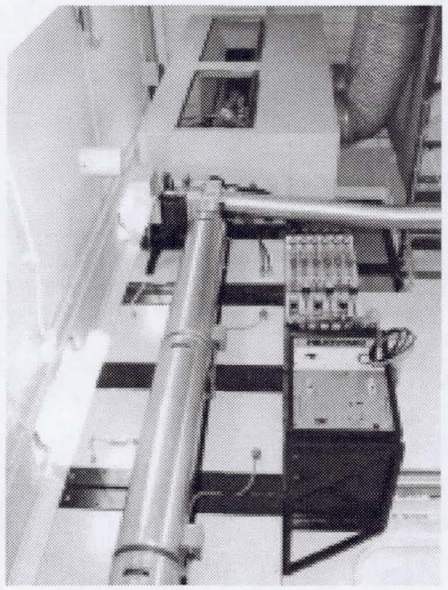
Purpose:
- Fabricate optical fiber with integrated sensors for aerospace applications



Primary Capabilities:
- Fabrication of custom optical fiber with distributed Bragg gratings and special polymeric coatings for strain, temperature and chemical sensing.

Special/Unique Capability:
- Excimer laser for producing photo-induced gratings while drawing fiber and before coating. This capability allows fabrication of sensing fibers without compromising fiber strength.

Equipment/Instrumentation:
- Graphite furnace
- Laser sensors for monitoring fiber diameter with feedback for control of draw speed
- Fully automated operation/Computer controlled
- UV curable and thermally cured coating capability
- Excimer laser

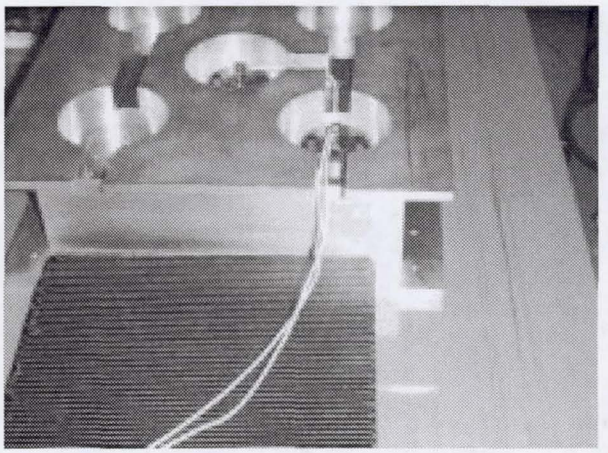


Point of Contact:
- Nondestructive Evaluation Laboratory, Building 1230B. Robert S. Rogowski (757) 864-4990 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Ultrasonic Cure Monitoring Equipment

Purpose:

- Monitor and control composite manufacturing to improve processes and yield better hardware.



Primary Capabilities:

- High-temperature, reusable in-mold ultrasonic sensors measure process parameters such as degree of cure without leaving witness marks on or embedded hardware in the part.

Special/Unique Capability:

- Plug-in high-temperature ultrasonic transducers capable of withstanding hundreds of thermal cycles up to 500° F.

Equipment/Instrumentation:

- 486 PC industrial computer with enhanced power supply
- Dual-channel 60 megasample/sec digitizer card
- Two ultrasonic pulser-receiver units and a function generator card
- 6 high temperature ultrasonic transducers (2.25-10 MHz)
- Ultrasonic mold for manufacturing 12"x12" test samples

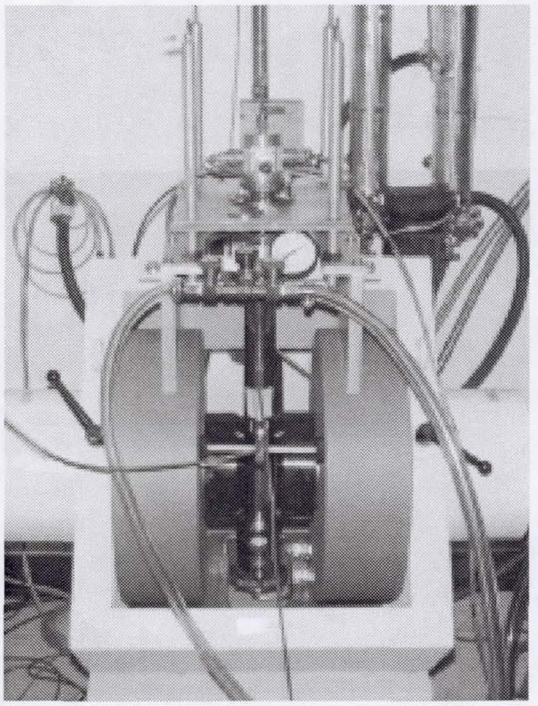
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230. Mr. Sid Allison (757) 864-4792 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Magneto-Resistance Measurement System

Purpose:

- Experimental tests of measure magneto-resistance and giant magneto-resistance of fabricated sensor materials.



Primary Capabilities:

- Experimentally measure change in resistance of nanostructured magnetic materials due to external field. Test types include 4 lead alternating and direct current resistivity measurements.

Equipment/Instrumentation:

- 2 Tesla applied field capability
- Field measurement accuracy of 3 mG.
- Full scale resistance measurement range of 2m_ to 2 M_ with accuracy of +-.02%
- Temperature control with range from 20 - 350 Kelvin.
- Full data storage, archival, and retrieval

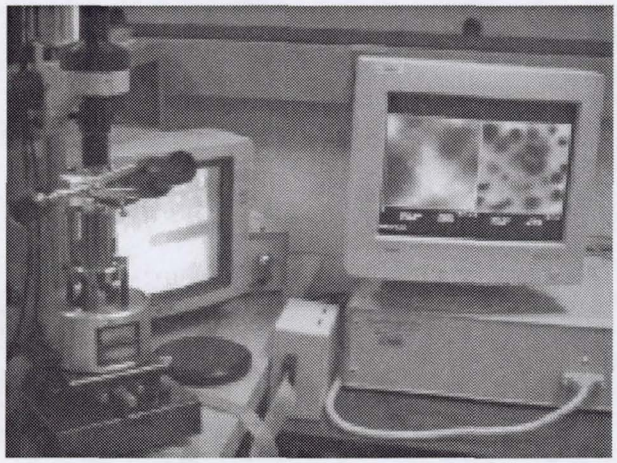
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230. Mr. Buzz Wincheski (757) 864-4798 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Micro and Nanostructure Evaluation Laboratory

Purpose:

- Characterization of material surface properties on micro and nanometer length scales.



Primary Capabilities:

- Evaluate structural and sensor materials on micrometer and nanometer length scales using a variety of scanning microscope techniques.

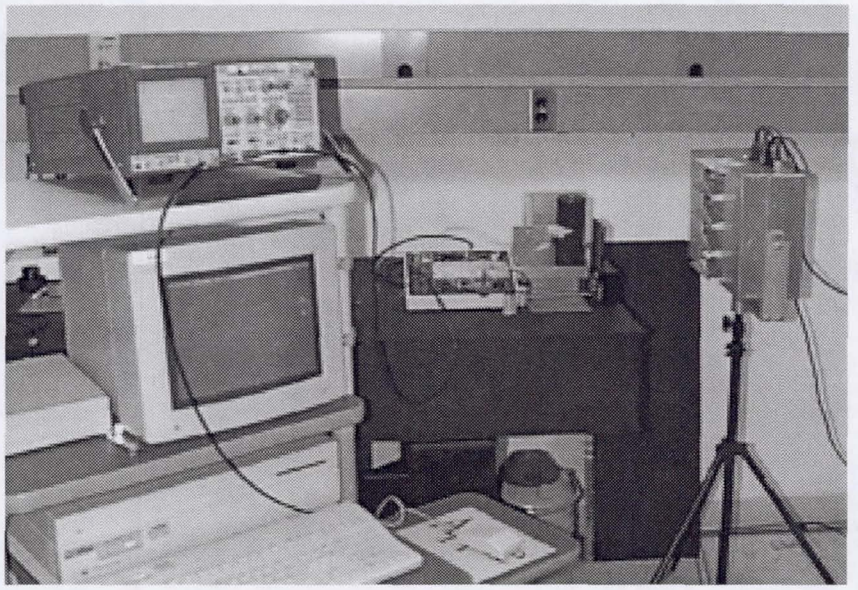
Equipment/Instrumentation:

- Scanning Electron Microscope
- Scanning Acoustic Microscope
- Scanning Tunneling Microscope
- Atomic Force Microscope
- Magnetic Force Microscope

Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230. Mr. Min Namkung (757) 864-4962 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Fast Noncontact Single Point Thermal NDE Equipment



Purpose:

- To experimentally determine thermal properties of test samples.

Primary Capabilities:

- Single point system used for measurement of thermal diffusivity on conductively fast or thin materials. Also used to characterize heat flux from flash and quartz lamps.

Special/Unique Capability:

- High sample rate (2 channels up to 32K samples per second) noncontact measurement of thermal diffusivity or thickness.

Equipment/Instrumentation:

- Flash or quartz lamp capability
- Variable signal sample rate up to 32K samples per second.
- 2 digitally recorded channels

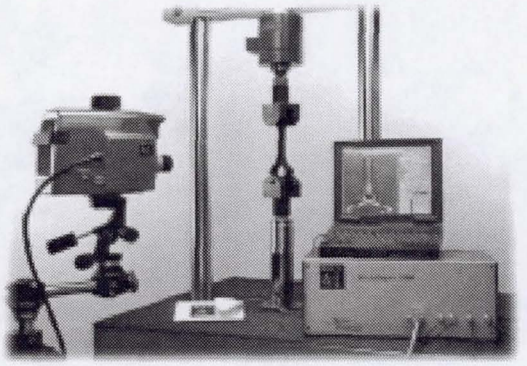
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Mr. Joe Zalameda (757) 864-4793 or Branch Head: Dr. Edward R.Generazio (757) 864-4970

Thermoelastic Stress Analysis System DeltaTherm 1000

Purpose:

- To experimentally determine the stress distribution in dynamically loaded structures and for crack detection.



Primary Capabilities:

- Measures small temperature variations in a sample induced by stress. Calculates the stress field causing these temperature variations, thus providing a dynamic image of rapidly varying stresses.

Special/Unique Capabilities:

- Very high-speed infrared array camera allows real-time calculations of the sum of the principal stresses over the entire image area.
- Can also be coupled to a spatially varying heat source and used for nondestructive inspection of cracks and disbonds.

Equipment/Instrumentation:

- 3-5 micron wavelength, 464 frame per second infrared array detector.
- Real time image-processing electronics for data collection and stress calculations.
- Computer controller and interface.
- Accepts interchangeable optics for small or large area inspections.
- 600 Watt computer controlled spatially varying heat source for NDE applications

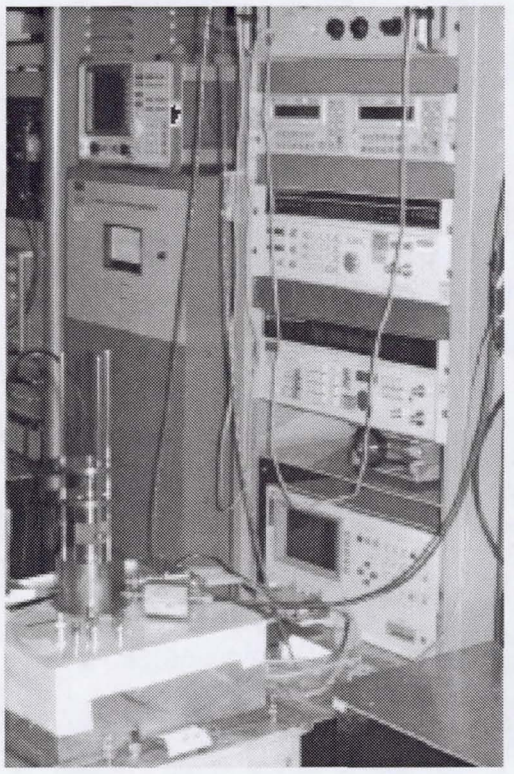
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. K. Elliott Cramer (757) 864-7945 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Nonlinear Ultrasonics Measurement System (Harmonic Generation Measurement System)

Purpose:

- To experimentally determine nonlinearity parameter in solids.



Primary Capabilities:

- Measurement of nonlinearity parameter of materials by measuring changes in ultrasonic waveform during passage through material. Nonlinearity parameters are affected by dislocations and residual stresses within materials. These are in turn affected by fatigue as well as precipitate growth, dissolution, heat treatment and mechanical working of alloys.

Special/Unique Capabilities:

- Capacitive detection of harmonic components. Measurement capability to particle displacement amplitudes as small as parts in 10^{-14} meters.
- Measurement capability includes up to third harmonic generation

Equipment/Instrumentation:

- Temperature and voltage stabilized amplitude measurement system
- 10-bit digitizing oscilloscope for waveform accuracy
- Sample size to 2 in. diameter x 3 in. length. Sample surfaces (prepared in house) flat and parallel. Check with POC about other sizes
- Sample surfaces prepared (in house) with flat and parallel surfaces
- Measurement system is computerized for operational ease

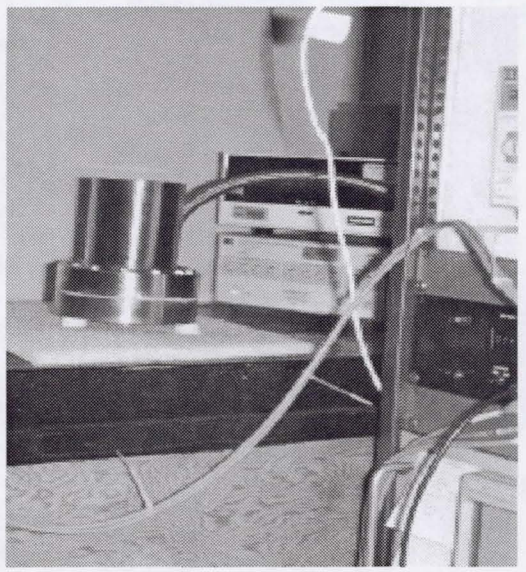
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. William T. Yost (757) 864-4991 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Nonlinear Ultrasonics Measurement System (Pressure Derivative Measurement System)

Purpose:

- To experimentally determine change in mechanical properties of materials with pressure (0-750 PSIG). System measures changes in phase velocity to parts in 10^9.



Primary Capabilities:

- Measurement of nonlinear mechanical properties of materials (changes in moduli with pressure).

Special/Unique Capability:

- Environmental chamber with temperature range from 77K to 340K

Equipment/Instrumentation:

- Constant Frequency Pulsed Phase-locked Loop
- Specimen spec range: from 1/2 in. dia x 1/2 in. length to 1in. dia x 1 in. length. Check with POC about other sizes
- Sample surfaces prepared (in house) with flat and parallel surfaces
- Measurement system is computerized for operational ease

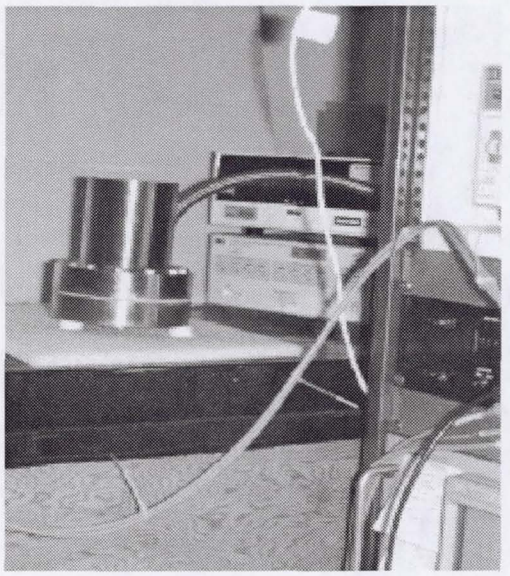
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. William T. Yost (757) 864-4991 or Branch Head: Dr. Edward R.Generazio (757) 864-4970

Nonlinear Ultrasonics Measurement System (Temperature Derivative Measurement System)

Purpose:

- To experimentally determine change in mechanical properties of materials with temperature System measures changes in phase velocity to parts in 10^9.



Primary Capabilities:

- Measurement of nonlinear mechanical properties of materials (changes in moduli with temperature). Temperature range from 77K to 340K

Special/Unique Capability:

- Environmental chamber with pressure range from 0-750PSIG

Equipment/Instrumentation:

- Constant Frequency Pulsed Phase-locked Loop
- Specimen spec range: from 1/2 in. dia x 1/2 in. length to 1 in. dia x 1 in. length. Check with POC about other sizes
- Sample surfaces prepared (in house). Surfaces must be flat and parallel.
- Measurement system is computerized for operational ease

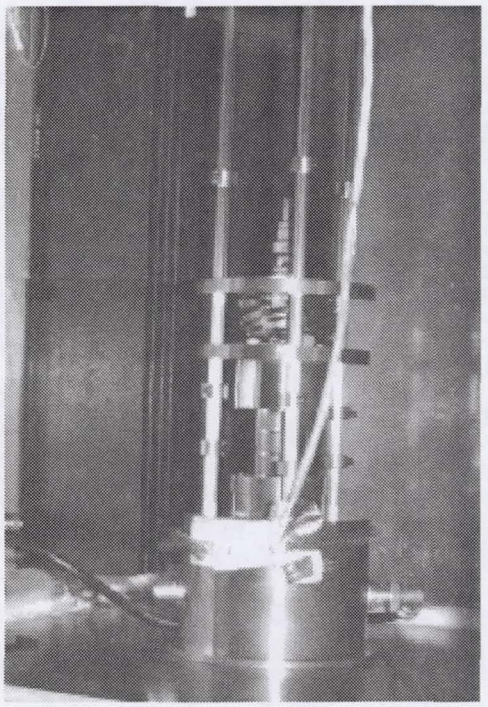
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. William T. Yost (757) 864-4991 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Ultrasonics Measurement System (Non-contacting Ultrasonic Velocity and Attenuation Measurement System)

Purpose:

- To experimentally determine ultrasonic velocity and attenuation in solids



Primary Capabilities:

- Measurement of ultrasonic velocities of materials to accuracies of parts in 10^5. Data is used to calculate moduli. Methods of excitation and reception require no bonds which affect measurement accuracy. Data is used for calculation of moduli under a diabatic conditions.

Special/Unique Capabilities:

- Capacitive drive and detection free of influence of bonds.
- Driver and detection are relatively broad-band. This permits attenuation measurements vs. frequency with Δf becoming small
- Diffraction correction algorithm is part of automated data-collection system

Equipment/Instrumentation:

- Temperature and voltage stabilized measurement system
- 10-bit digitizing oscilloscope for waveform accuracy
- Sample size to 2" diameter x 3 in. length. Sample surfaces (prepared in house) flat and parallel. Check with POC about other sizes
- Sample surfaces prepared (in house) with flat and parallel surfaces
- Measurement system is computerized for operational ease

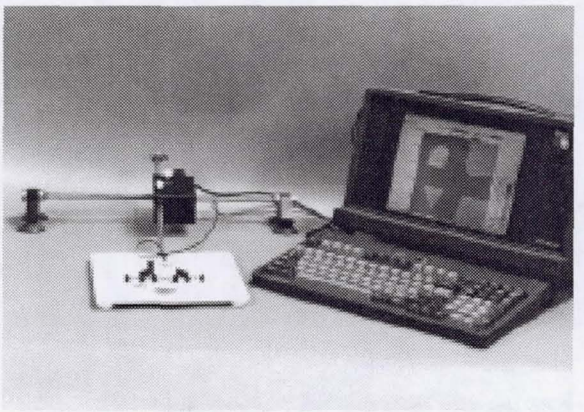
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. William T. Yost (757) 864-4991 or Branch Head: Dr. Edward R.Generazio (757) 864-4970

Portable Ultrasonic Scanning System for Aging Aircraft

Purpose:

- To measure disbond and corrosion damage in thin aluminum airframe structures



Primary Capabilities:

- Can be taken to aircraft in a hanger or on the tarmac
- Forms image of thinning
- Requires minimal user adjustments

Special/Unique Capabilities:

- Trained neural network interprets bond/disbond condition
- Spectral analysis determines thinning

Equipment/Instrumentation:

- Portable PC containing pulser/receiver, digitizer, position encoder
- Manual or motorized scanning
- Water-coupled transducer

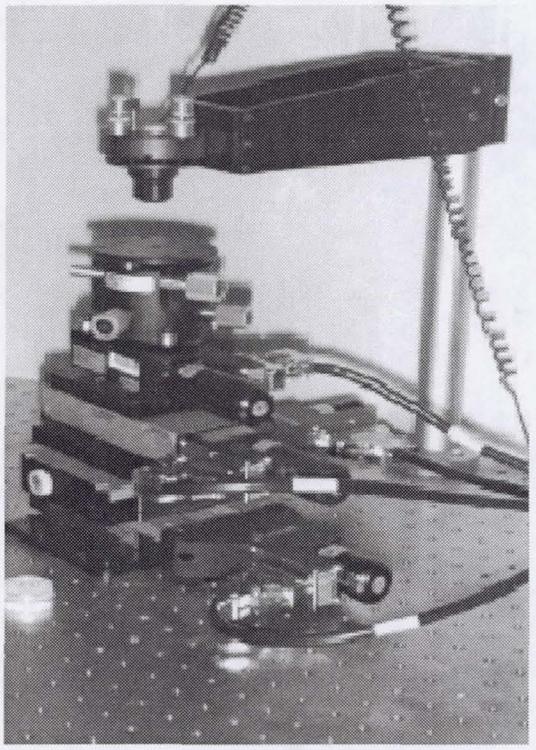
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. Patrick Johnston (757) 864-4966 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Nonlinear Ultrasonics Measurement System (Beam Mixing Measurement System for use as Metal Fatigue Monitor)

Purpose:

- To experimentally determine change in mechanical properties of materials with fatigue. System measures changes in the ultrasonic nonlinearity parameter by the generation of waveforms of sum and difference frequencies.



Primary Capabilities:

- Measurement of state of fatigue in materials during service life

Special/Unique Capability:

- System can be used in scanning mode

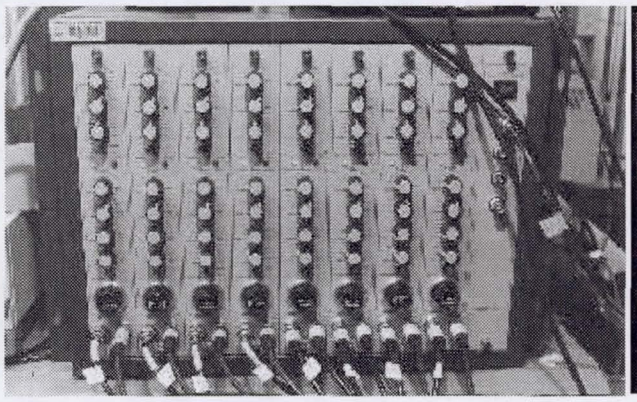
Equipment/Instrumentation:

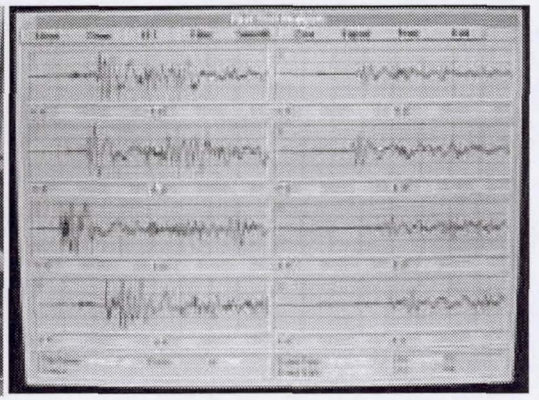
- Scanning system capable of x and y displacements of ±2 cm
- Maximum specimen specs: 2 in. x 2 in. thickness up to 1 in.
- Sample surfaces flat
- Measurement system is computerized for operational ease

Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. William T. Yost (757) 864-4991 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Waveform Based Acoustic Emission (AE) System





Purpose:

- To record and analyze sound waves produced by damage mechanisms such as fatigue cracking when a material or structure is under load.

Primary Capabilities:

- Used to monitor damage progression during mechanical testing of material coupons in the laboratory or for structural health monitoring.

Special/Unique Capabilities:

- Full digital waveform capture at 12 bit vertical resolution and up to 30 MHz sampling frequency
- Automated "Modal AE" software for noise discrimination, accurate source location, and source identification.

Equipment/Instrumentation:

- 20 AE waveform measurement channels and 12 parametric measurement channels to record variables such as load, strain, or pressure.
- Gain and filtering independently set on trigger and data acquisition signal paths

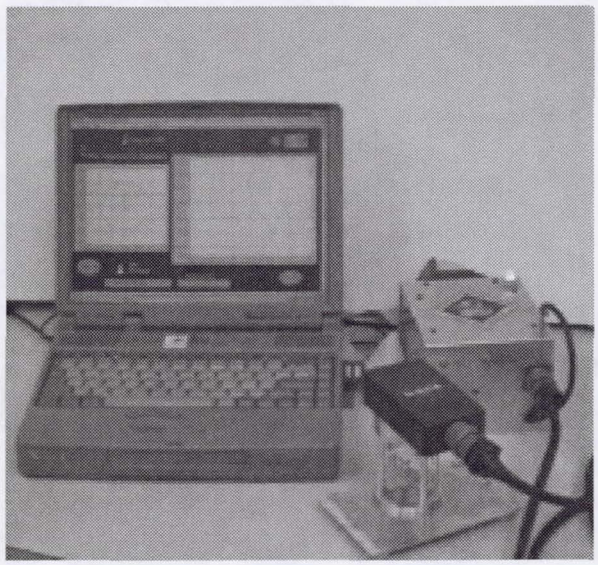
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. William H. Prosser (757) 864-4960 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Rotating Self-Nulling Eddy Current Probe System

Purpose:

- To detect fatigue damage hidden under airframe fasteners.



Primary Capabilities:

- System has a 90% probability of detection for 0.8 mm long fatigue cracks in outer fuselage skin and 2.5 mm fatigue cracks hidden under two unflawed outer skin layers.

Special/Unique Capability:

- Extremely portable and user friendly technique for the detection of sub-millimeter fatigue cracks under airframe fasteners.

Equipment/Instrumentation:

- 1.5 kHz - 120 kHz Self-Nulling Probe
- 3 Hz rotation frequency
- Scan radius adjustable out to 6.35 mm.
- Full data archival, storage and retrieval

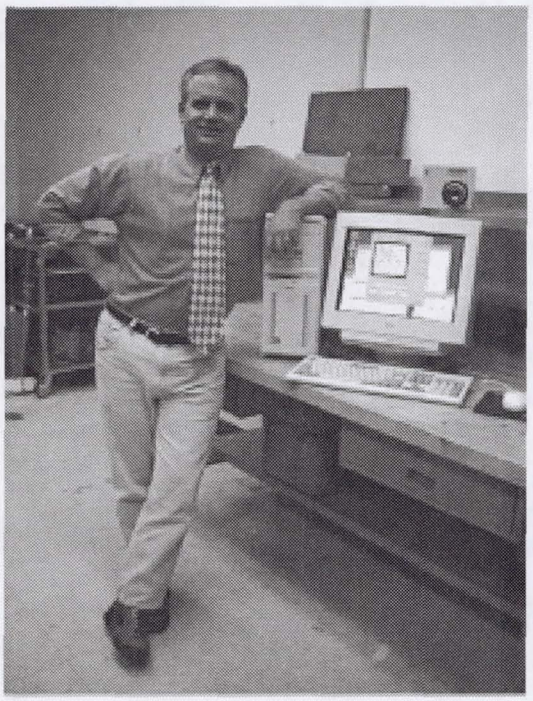
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230. Mr. Buzz Wincheski (757) 864-4798 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Thermal NDE Equipment

Purpose:

- To experimentally determine thermal properties of materials and for rapid large area defect detection.



Primary Capabilities:

- Measure thermal diffusivity of samples in both a single-sided and through-transmission configuration. Image defects such as voids, delaminations, and corrosion in materials.

Special/Unique Capability:

- Very high speed infrared cameras. Capable of both impulse and step thermal excitation for handling a wide variety of material thicknesses and thermal properties.

Equipment/Instrumentation:

- 1,400 frame per second maximum frame rate.
- Near real time thermal diffusivity imaging.
- Real time floating-point imaging processing capabilities.
- 6.4 Kjoule pulse heat input or 4000-Watts step heat input.
- 12 bit image digitizing.
- 20-milliKelvin NEΔT temperature sensitivity over a 0-100°C temperature range.

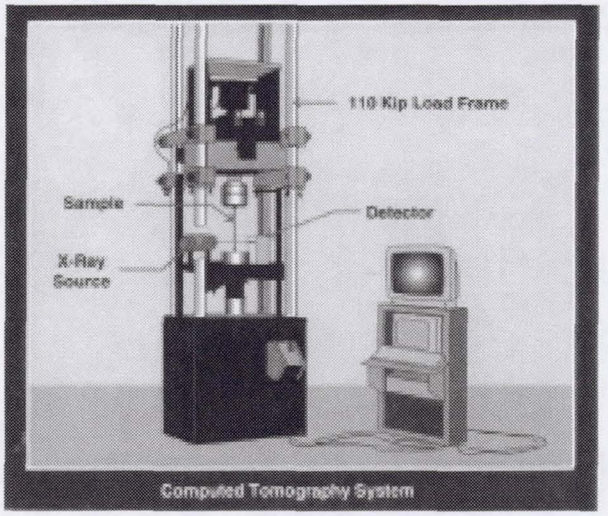
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. K. Elliott Cramer (757) 864-7945 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Quantitative Experimental Stress Tomography System

Purpose:

- To perform computed tomography imaging of materials/structures



Primary Capabilities:

- X-ray imaging of materials/structures to obtain quantitative information on features of interest such as voids, delaminations, microcracks, inclusions, corrosion, density variations and porosity

Special/Unique Capabilities:

- Load frame capable of applying loads up to +/- 56,000 lbs.
- Capable of resolving small defects over a relatively large field of view.

Equipment/Instrumentation:

- 160 keV microfocus x-ray source
- 8192 element scintillating detector array
- Optimal spatial resolution 12.5 microns
- Maximum field of view 3.5 in.
- 56,000 lb. Load capability

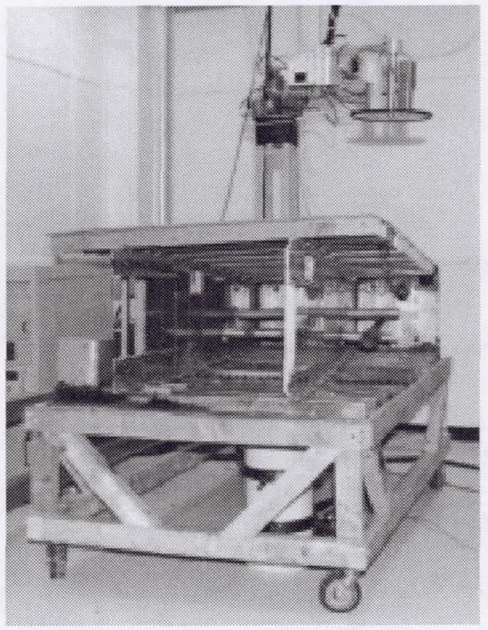
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. William P. Winfree (757) 864-4963 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Reverse Geometry X-ray System

Purpose:

- To perform real-time x-ray imaging of materials/structures



Primary Capabilities:

- Digital radiography and laminography for imaging material/structural features of interest such as corrosion, voids, inclusions, delaminations, cracks, density variations and porosity.

Special/Unique Capabilities:

- X-ray detector can be miniaturized and easily positioned inside a complex structure enabling imaging of each surface separately.
- Multiple detectors enable simultaneous acquisition of data from several different perspectives without moving the structure or the measurement system. This provides a means for locating the position of flaws and enhances separation of features at the surface from features inside the structure.
- Reduced secondary scattered radiation, compared with traditional radiography, simplifies the conversion of radiographs to quantitative images.

Equipment/Instrumentation:

- 160 keV scanned x-ray source with a 10 in. diameter field of view
- 8 point detectors
- Lead lined room for large structure inspection (up to 8ft. x 8 ft.)

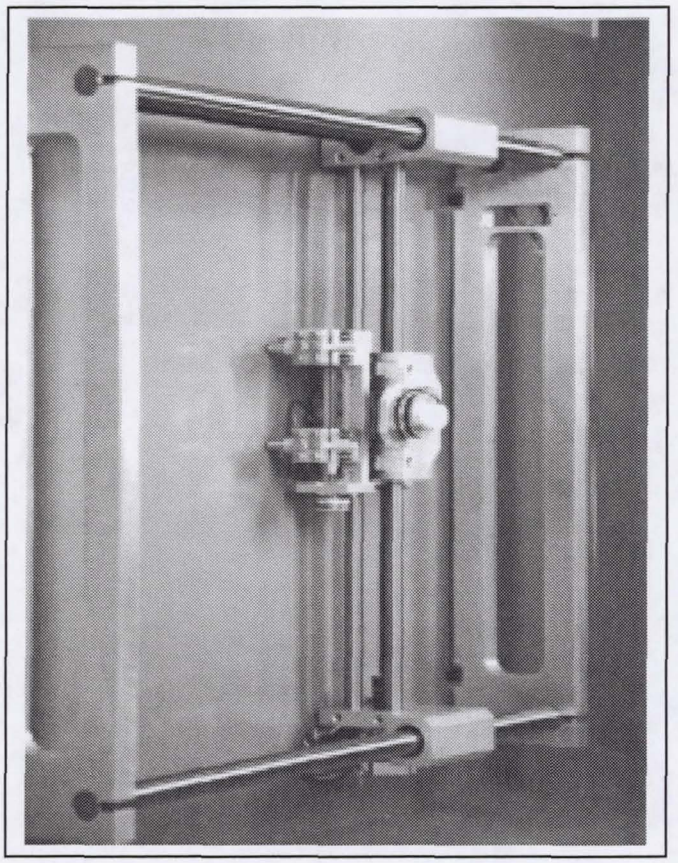
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. William P. Winfree (757) 864-4963, F. Raymond Parker (757) 864-4965, or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Lamb Wave Measurement System

Purpose:

- Generate and detect Lamb wave signals in composites.



Primary Capabilities:

- System can generate dispersion curves for Lamb waves and compute elastic coefficients of the materials.

Special/Unique Capability:

- Capable of generating and detecting Lamb waves from 30 to 300 Khz.
- Can measure the velocity of the Lamb waves and scan an area approximately 60 cm by 60 cm.
- System requires no couplet.
- System is compact for in-situ measurements.

Equipment/Instrumentation:

- Custom system made by Digital Wave Corp.
- Based on a PC controller with a scanning bridge with inversion software.

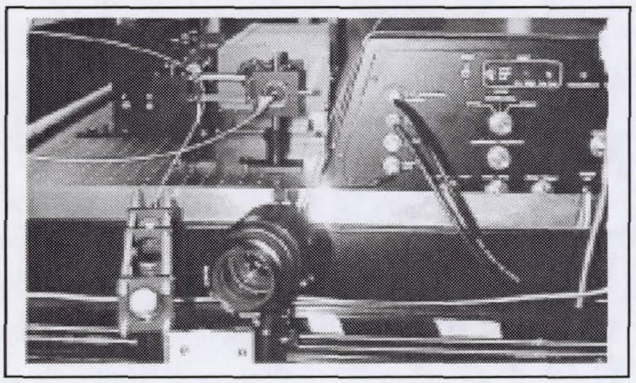
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. Eric Madaras (757) 864-4993 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Laser Based Ultrasound System

Purpose:

- Generate and detect ultrasonic signals in a non-contacting, remote manner with less sensitivity to geometry.



Primary Capabilities:

- Generate and detect ultrasound in a pulse echo manner in thick composites.

Special/Unique Capability:

- Capable of generating and detecting ultrasound in composites up to 1" thick.

Equipment/Instrumentation:

- Remote ultrasound generation with Nd:YAG, Ho:YAG, Er:YAG, Alexandrite lasers and laser diodes.
- Remote ultrasound detection with cavity stabilized Fabry-Perot interferometer and cw frequency doubled Nd:YAG or long pulse laser

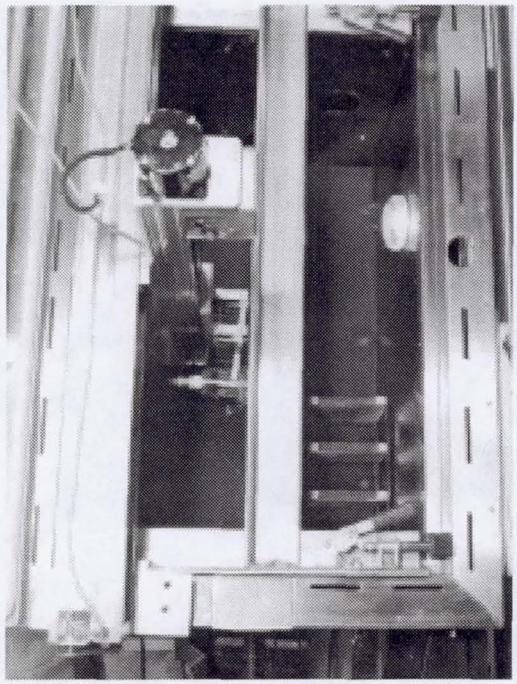
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. Eric Madaras (757) 864-4993 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Long Duration Test Facility Ultrasound System

Purpose:

- Measure ultrasonic properties of composite materials undergoing aging tests in the Long Duration Test Facilities.



Primary Capabilities:

- Generate and detect ultrasound in a pulse echo manner in composites loaded in environmental chambers.

Special/Unique Capability:

- Able to measure composites while loaded in their testing stands.

Equipment/Instrumentation:

- Computer controlled system with pulser/receiver and digitizer.
- Transducer mounted in a bubbler.

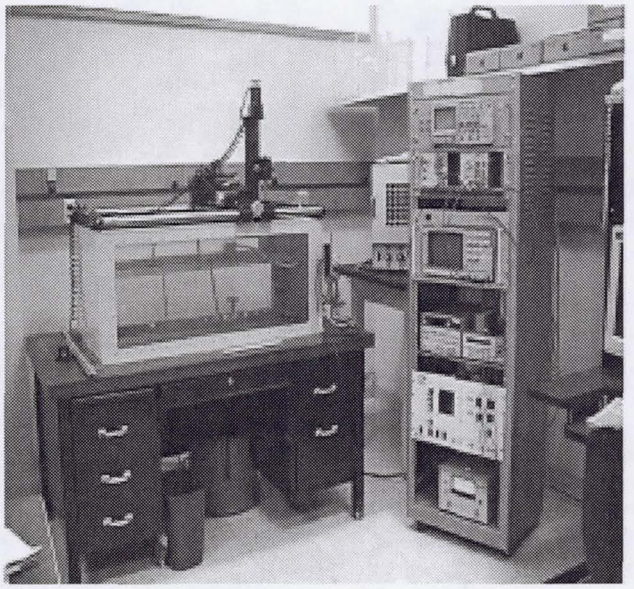
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230. Dr. Eric Madaras (757) 864-4993 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Single Bridge 3-Axis Ultrasonic Scanning System

Purpose:

- To experimentally measure ultrasonic properties of materials and structures



Primary Capabilities:

- One X-Y-Z bridge and a turntable
- Pulse-echo and transmission measurements
- 48" x 18" x 26" Tank

Special/Unique Capability:

- Can be operated as a rectilinear X-Y-Z scanner or X-Z-__using the turntable

Equipment/Instrumentation:

- Pulse, tone burst, or arbitrary waveform transmit
- Peak detection, time of flight, or digitized waveform receiving

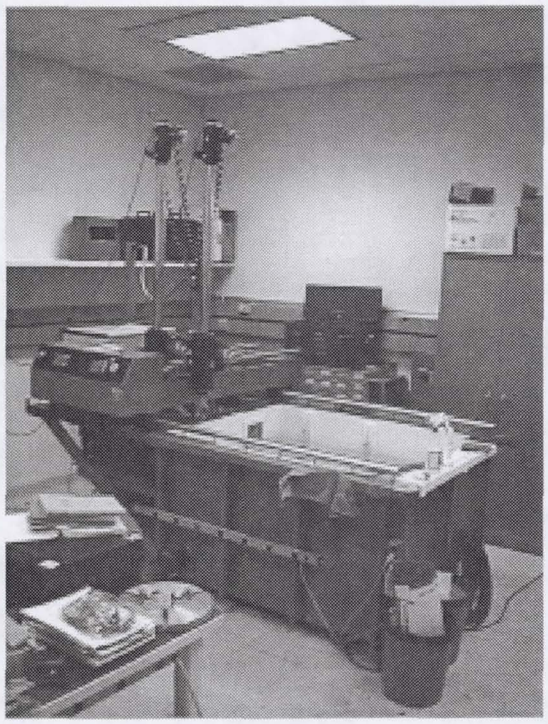
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. Patrick Johnston (757) 864-4966 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Eight Axis Ultrasonic Scanning System

Purpose:

- To experimentally measure ultrasonic properties of materials and structures



Primary Capabilities:

- X-Y Scanning bridge
- Two independent transducer manipulators with Z axis, gimbal and swivel control
- Pulse-echo and transmission measurements
- 48" x 60" x 36" Tank

Equipment/Instrumentation:

- Pulse, tone burst, or arbitrary waveform transmit
- Peak detection, time of flight, or digitized waveform receiving

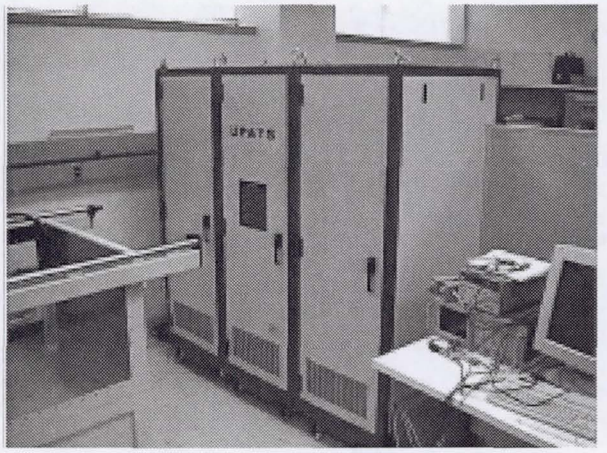
Point of Contact:

- Nondestructive Evaluation Laboratory, Building 1230B. Dr. Patrick Johnston (757) 864-4966 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Ultrasonic Phased Array Test-bed System (UPATS)

Purpose:

- To experimentally study ultrasonic beam formation and control
- To study material and structural properties measured by ultrasonic arrays
- To establish design parameters for lower-cost ultrasonic instrumentation for particular difficult NDE problems



Primary Capabilities:

- Controls up to 100 independent ultrasonic transducers, acting individually or as one or more array units

Special/Unique Capability:

- Can be adapted to many different transducer array configurations

Equipment/Instrumentation:

- Arbitrary waveform source on transmit
- Independent transmit gain and delay control on each channel
- Independent receive gain and delay control on each channel
- Signal bandwidth from 100 kHz to 7.5 MHz

Point of Contact:

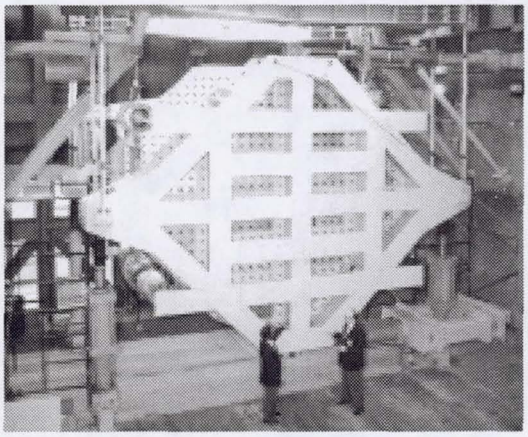
- Nondestructive Evaluation Laboratory, Building 1230B. Dr. Patrick Johnston (757) 864-4966 or Branch Head: Dr. Edward R. Generazio (757) 864-4970

Combined Loads Test Systems Facility (Bldg 1256)

Combined Loads Test Machine

Purpose:

- To study the behavior of curved panels and cylindrical structures subjected to combined mechanical loads, internal pressure and elevated temperature conditions.



Primary Capabilities:

- Combined axial, shear, and internal pressure loading on curved panels
- Combined axial, torsion, and internal pressure loading on cylindrical structures
- Axial loads up to 2,700 kips
- Shear loads up to 600 kips
- Torsion loads from 300-kip actuators, 22 ft apart
- Internal pneumatic pressure up to 20 psig
- Cyclic loading capability; spectrum fatigue loading at up to 5 cycles/min for mechanical loading and up to 1 cycle/min for cyclic pressure loading
- Cylindrical structures up to 15-ft diameter,
- Test structure length; 10-, 15-, 20-, 30-, and 45-ft
- Temperature up to 400° F

Special/Unique Capability:

- Accommodates curved panels up to125-inch radius, 96-in-wide, and 120-inch long using a D-box test fixture

Equipment/Instrumentation:

- Data aquisition; 1024-channels
- 32-channel closed-loop feedback control system
- Video and still cameras

Point of Contact:

- Combined Loads Test System Facility, Building 1256. Marshall Rouse (757) 864-3182 or Branch Head: Dr. Damodar R. Ambur (757) 864-3174

Aircraft Landing Dynamics Facility (Bldg 1262)

Diagonal Braking Vehicle (DBV)

Purpose:

- The Diagonal Braking Vehicle is a specially modified 1969 Ford XL equipped with a high performance engine, safety roll bar, special brake control valve system, instrumentation and data acquisition system used to measure the coefficient of friction on wet, dry, snow, and/or ice covered runway and roadway surfaces (dirt, concrete, and asphalt).

Primary Capabilities:

- Test speeds from 0 to 120 MPH

Equipment/Instrumentation:

- Self-contained Macintosh computer data acquisition and analysis system capable of recording 6 channels of data at a maximum of 1000 HZ sample rate.

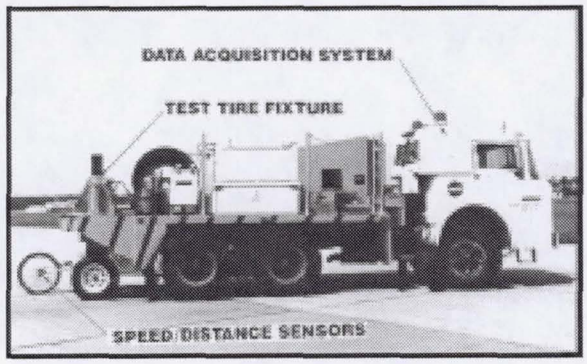
Point of Contact:

- Aircraft Landing Dynamics Facility, Building 1262. Thomas J. Yager (757) 864-1304 or Branch Head: Dr. Howard M. Adelman (757) 864-2804

Instrumented Tire Test Vehicle (ITTV)

Purpose:

- The Instrumented Tire Test Vehicle (ITTV) is a 1976 Ford CT 900 truck with a 180 HP, V-8 engine used to evaluate tire performance during straight ahead rolling, yawed rolling, camber or braking test runs on runway and roadway surfaces (dirt, concrete or asphalt).



Primary Capabilities:

- Maximum vertical load of 5000 pounds (22.2 KN)
- Maximum drag and side loads of 3000 pounds (13.3 KN)
- Maximum speed of 65 MPH (105 KM/H)
- Variable fixed slip ratio on test tire
- Adjustable yaw and camber angle

Special/Unique Capabilities:

- Tire footprint aspect ratio effect on hydroplaning speed
- Radial belted and bias ply tire friction/wear performance
- Space Shuttle landing runway friction and wear study
- Landing gear skid material friction and wear
- Aircraft nose tire foreign object debris (FOD) and water spray dispersal pattern study

Equipment/Instrumentation:

- Self-contained Macintosh computer data acquisition and analysis system capable of recording 12 channels of data at a maximum of 1000 HZ sample rate.

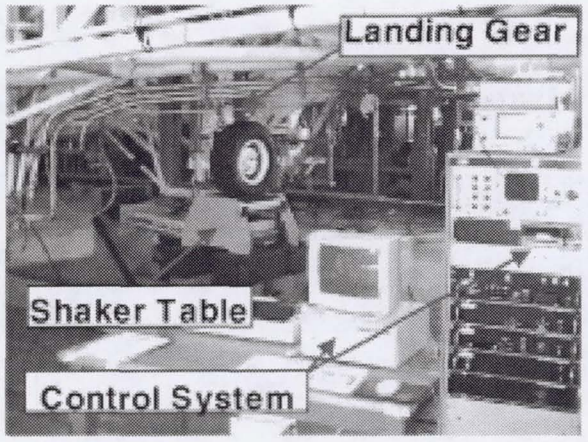
Point of Contact:

- Aircraft Landing Dynamics Facility, Building 1262. Robert H. Daugherty (757) 864-1309 or Branch Head: Dr. Howard M. Adelman (757) 864-2804

Runway Profile Simulator

Purpose:

- The purpose of this equipment is to simulate the vibratory input of the runway surface during aircraft taxi, departure and landing operations. This is accomplished by hydraulically driving the shaker table vertical movement to correspond to a specific runway profile. By mounting an aircraft landing gear system on a vertical slide over the shaker table, this system can be used to study and characterize the behavior of the landing gear components.



Primary Capabilities:

- Maximum static load on shaker head is 12,000 pounds with an additional dynamic load of 10,000 pounds over a frequency range DC to 50 HZ.
- Simulate a 1 inch step bump at 100 knots
- Simulate a 1-COS bump or other user defined waveforms up to 50 HZ with a 2 inch amplitude at a dynamic force of at least 10,000 pounds for a minimum of 2 cycles
- Maximum head velocity is 170 inches/sec
- Frictionless
- Slip plate between tire and shaker head
- Maximum shaker head stroke plus or minus 3 inches

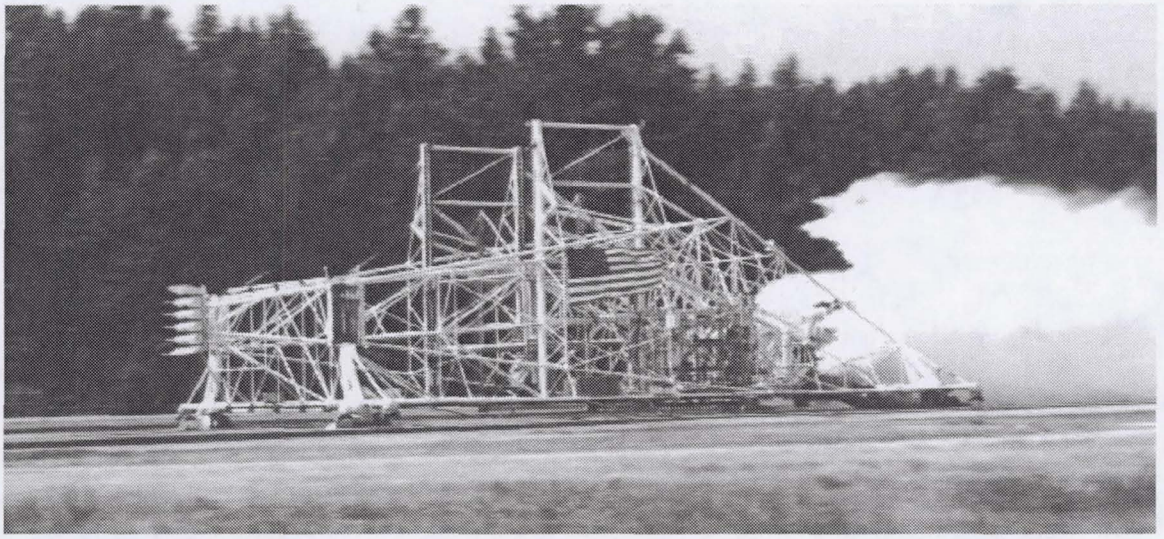
Equipment/Instrumentation:

- Self-contained Macintosh computer data acquisition and analysis system capable of recording 16 channels of data at a maximum of 3000 HZ sample rate.

Point of Contact:

- Aircraft Landing Dynamics Facility, Building 1262. Robert H. Daughetry (757) 864-1309 or Branch Head: Dr. Howard M.Adelman (757) 864-2804

20g Carriage at 220 knots



Purpose:

- To conduct research for improving the safety and handling performance of aircraft during all-weather ground operations, including takeoff, landing impact, and ground handling phenomena. Runway treatments and effects on aircraft and tire performance are assessed.

Primary Capabilities:

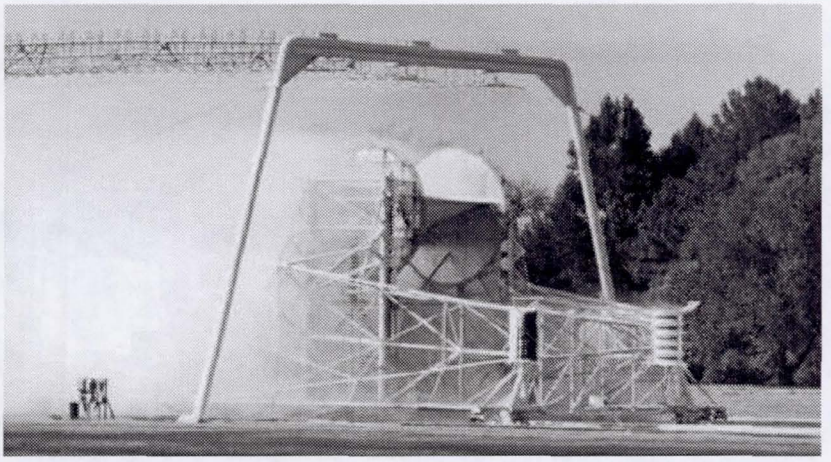
- Carriage Test Speed - Maximum 220 knots
- Test Carriage Weight - 120,000 lbs. capable of a maximum acceleration pulse of 20g
- Maximum Vertical Load on test article - 70,000 lbs.
- Yaw angle - Adjustable
- Length of track - 2800 Feet
- Catapult distance - 400 Feet
- Test Section Length - 1800 Feet
- Arresting distance - 600 Feet
- Turn around time for each test - 1 hour

Special/Unique Capabilities:

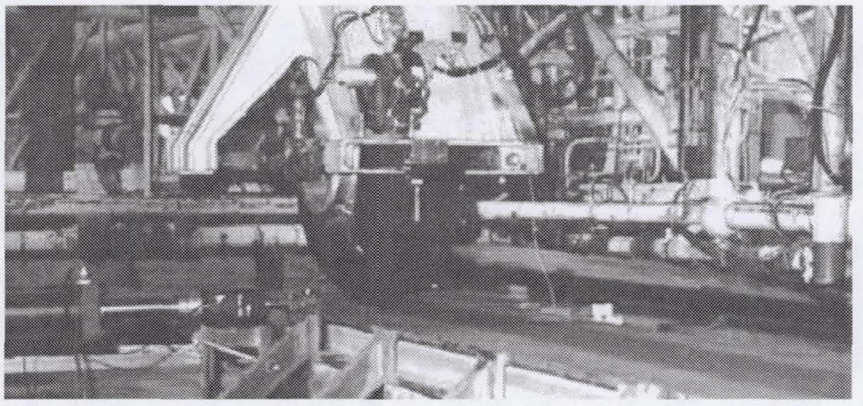
- Water irrigation system designed to wet runway surfaces before tests
- 6'4" Wide X 8 ' Deep Water Tow Tank parallel to track

Equipment/Instrumentation:

- PC based data acquisition and analysis system capable of transferring data over the Internet
- 28 channel telemetry system capable of 1066 samples/sec/channel



A wing section mounted on the test carriage and catapulted through a rain simulator to measure the effects on lift and drag of different rain rates.



A special runway platform was fabricated in the carriage storage building that would allow vertical loads of 120,000 pounds and side loads of 60,000 pounds to be applied to aircraft tires for special testing applications

Test tire mounted on the carriage dynamometer loaded on the runway surface.

Landing skid test on carriage

Point of Contact:

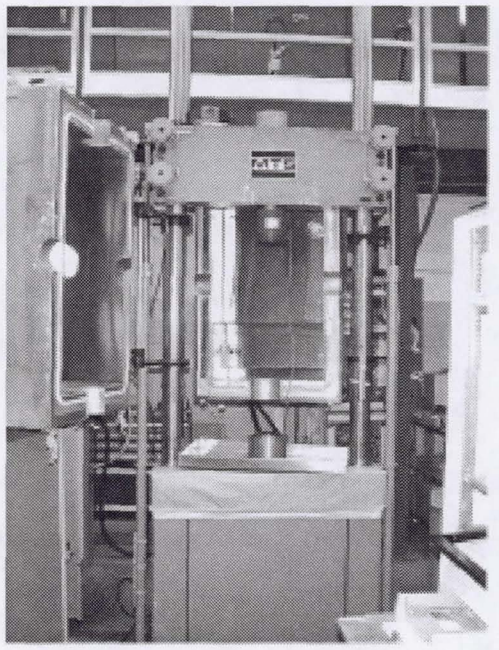
- Aircraft Landing Dynamics Facility, Building 1262. Robert H. Daughetry (757) 864-1309 or Branch Head: Dr. Howard M. Adelman (757) 864-2804

Thermal Structures Laboratory
(Bldg 1267)

MTS 110-Kip Test Machine

Purpose:

- Conduct analytical and experimental research to understand the behavior of advanced complex structures subject to static and time-varying mechanical and thermal loads.



Primary Capabilities:

- Test for mechanical properties of element-sized structural panels subject to thermal and mechanical loads.
- 110,000 lb. load capability.
- Maximum specimen length 6 ft without oven, 2 ft with oven.
- Actuator speed 0.001 to 0.5 in/min.

Special/Unique Capability:

- Environmental chamber with temperature range of approximately -320°F to 600°F.

Equipment/Instrumentation:

- Data acquisition system recording up to 256 channels of data (typical, 256 additional channels available) with real-time plots and readout in engineering units.

Point of Contact:

- Thermal Structures Laboratory, Building 1267. Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Shore Western 220-Kip Test Machine

Purpose:

- Conduct analytical and experimental research to understand the behavior of advanced complex structures subject to static and time-varying mechanical and thermal loads.

Primary Capabilities:

- Test for mechanical properties of element-sized structural panels subject to thermal and mechanical loads.
- 220,000 lb. load capability without grips (three of these machines available).
- 110,000 lb. load capability with grips.
- Maximum specimen length 6 ft without oven, 3 ft with oven.
- Actuator speed 0.001 to 0.5 in/min.

Special/Unique Capability:

- Environmental chamber available for this load frame with temperature range of -320°F to 600°F.

Equipment/Instrumentation:

- Data acquisition system recording up to 256 channels of data (typical, 256 additional channels available) with real-time plots and readout in engineering units.

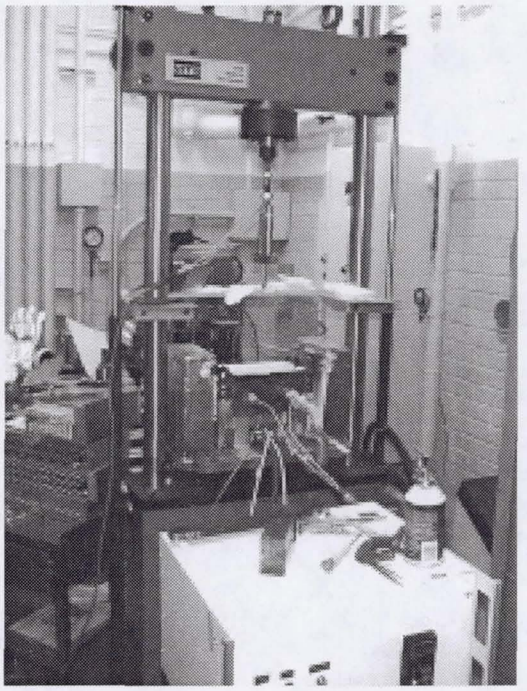
Point of Contact:

- Thermal Structures Laboratory, Building 1267. Branch Head: Dr. Stephen J. Scotti (757) 864-5431

MTS 22-Kip Test Machine

Purpose:

- Conduct analytical and experimental research to understand the behavior of advanced complex structures subject to static and time-varying mechanical and thermal loads.



Primary Capabilities:

- Test for mechanical properties of element-sized structural panels subject to thermal and mechanical loads.
- 22,000 lb. load capability.
- Maximum specimen length 4 ft without oven, 1 ft with oven.
- Actuator speed 0.001 to 0.5 in/min.

Special/Unique Capability:

- Environmental chamber with temperature range up to 1800°F.

Equipment/Instrumentation:

- Data acquisition system recording up to 256 channels of data (typical, 256 additional channels available) with real-time plots and readout in engineering units.

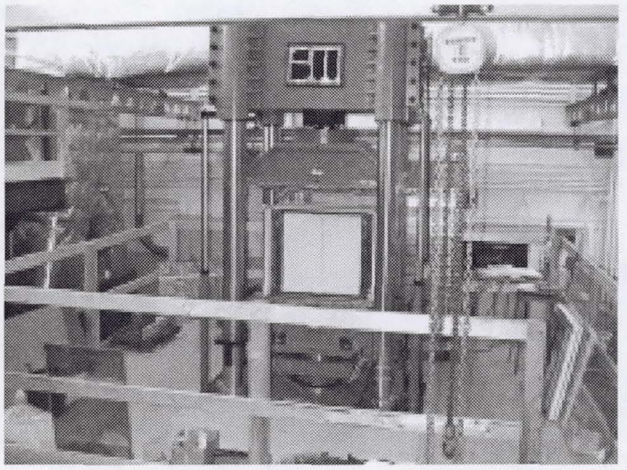
Point of Contact:

- Thermal Structures Laboratory, Building 1267. Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Shore Western Test Frame 500-Kip Test Machine 1

Purpose:

- Conduct analytical and experimental research to understand the behavior of advanced complex structures subject to static and time-varying mechanical and thermal loads.



Primary Capabilities:

- Test for mechanical properties of small subcomponent-sized structural panels subject to thermal and mechanical loads.
- 500,000 lb. Load capability.
- Maximum specimen length 7 ft.
- Actuator speed 0.001 to 0.5 in/min.

Special/Unique Capability:

- Specifically adapted for testing specimens in compression.

Equipment/Instrumentation:

- Data acquisition system recording up to 256 channels of data (typical, 256 additional channels available) with real-time plots and readout in engineering units.

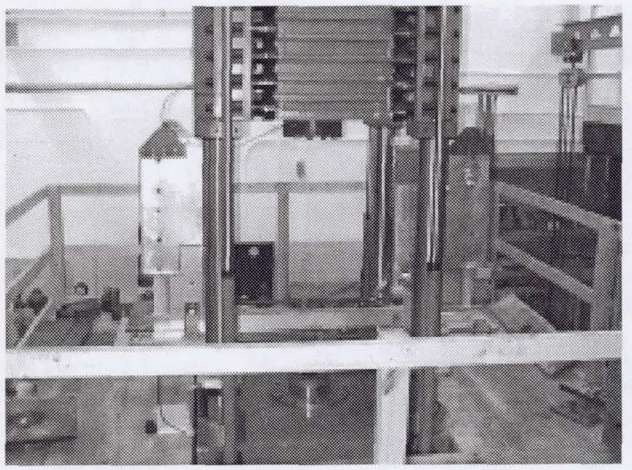
Point of Contact:

- Thermal Structures Laboratory, Building 1267. Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Shore Western Test Frame 500-Kip Test Machine 2

Purpose:

- Conduct analytical and experimental research to understand the behavior of advanced complex structures subject to static and time-varying mechanical and thermal loads.



Primary Capabilities:

- Test for mechanical properties of small subcomponent-sized structural panels subject to thermal and mechanical loads.
- 500,000 lb. load capability.
- Maximum specimen length 7 ft without oven, 2ft with oven.
- Actuator speed 0.001 to 0.5 in/min.

Special/Unique Capabilities:

- Specifically adapted for testing specimens in tension.
- Environmental chamber with temperature range of -320°F to 600°F.

Equipment/Instrumentation:

- Data acquisition system recording up to 256 channels of data (typical, 256 additional channels available) with real-time plots and readout in engineering units.

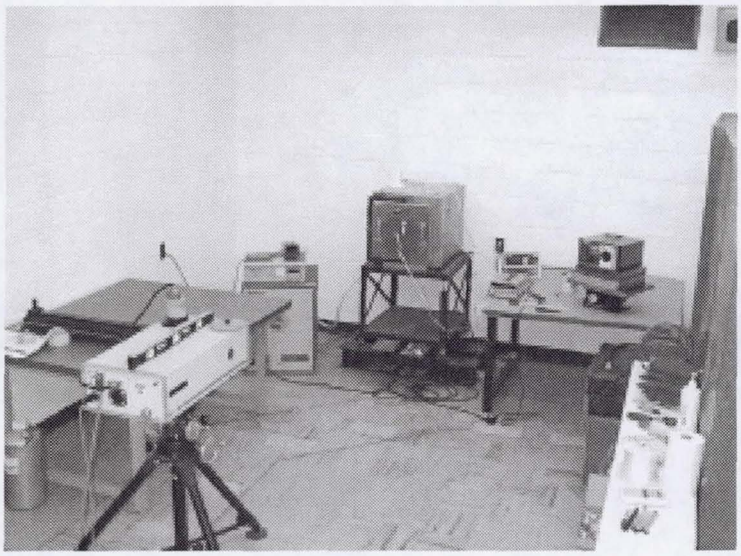
Point of Contact:

- Thermal Structures Laboratory, Building 1267. Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Optical Properties Laboratory

Purpose:

- Conduct experimental research to determine the optical radiant properties of aerospace structures at temperatures up to 1800°F.



Primary Capability:

- Measure the normal spectral emittance of various aerospace structures at temperatures up to 1800°F.

Special/Unique Capabilities:

- Environmental chamber with temperature range up to 1800° F.
- Spectral data in the 1 to 14 micrometer range.

Equipment/Instrumentation:

- Spectro-radiometer with circular variable filter unit covering 1 to 14 micrometer range.
- Test specimen furnace for temperatures up to 1800°F.
- Two blackbody radiation sources up to 1800°F.

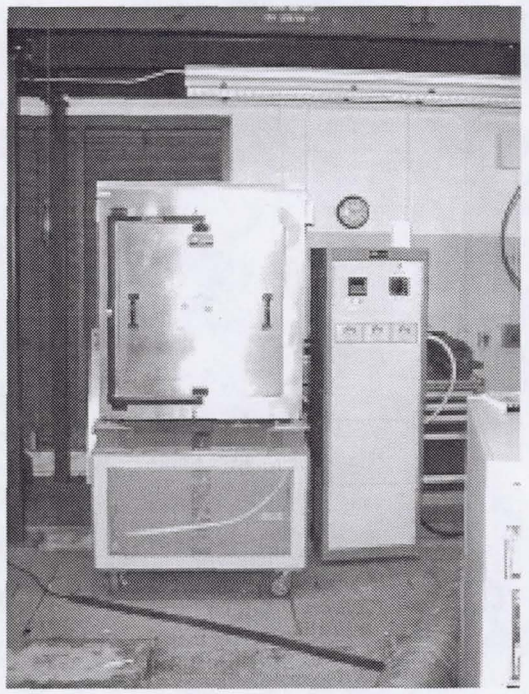
Point of Contact:

- Thermal Structures Laboratory, Building 1267. Kamran Daryabeigi (757) 864-4745 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

High Temperature Test Furnace

Purpose:

- Conduct analytical and experimental research to understand the behavior of advanced complex structures subject to static and time-varying mechanical and thermal loads.



Primary Capability:

- Test for thermal properties of element-sized structural panels.

Special/Unique Capabilities:

- Five environmental chambers with temperature range of -320°F to 2800°F.
- Maximum specimen size approximately 33" x 24" x 24".

Point of Contact:

- Thermal Structures Laboratory, Building 1267. Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Thermal Infrared Camera

Purpose:

- Provide qualitative and quantitative non-intrusive, global surface temperature measurement on advanced complex structures subject to static and time-varying mechanical and thermal loads.

Primary Capabilities:

- Surface temperature measurement of structural panels subject to thermal and mechanical loads.

Special/Unique Capability:

- Global, non-intrusive surface temperature measurement capability up to 1800° F.

Equipment/Instrumentation:

- Infrared camera with spectral response of 8 to 12 micrometers.

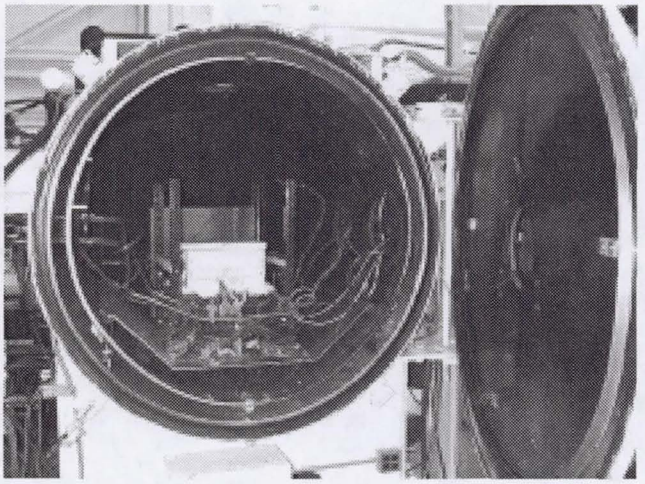
Point of Contact:

- Thermal Structures Laboratory, Building 1267. Kamran Daryabeigi (757) 864-4745 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Thermal Conductivity Measurement Apparatus

Purpose:

- Conduct analytical and experimental research to model the coupled heat transfer mechanisms in high temperature insulations for re-entry space transportation vehicles.



Primary Capabilities:

- Measure effective thermal conductivity of high temperature insulations, at pressures from 10^{-4} – 760 torr, subject to temperature gradients from 100 to 1800°F.
- Specimen size up to 12 inch by 12 inch, 2 inch thick.

Special/Unique Capability:

- Capable of measuring thermal conductivity of samples subject to temperature gradients as large as 1800°F.

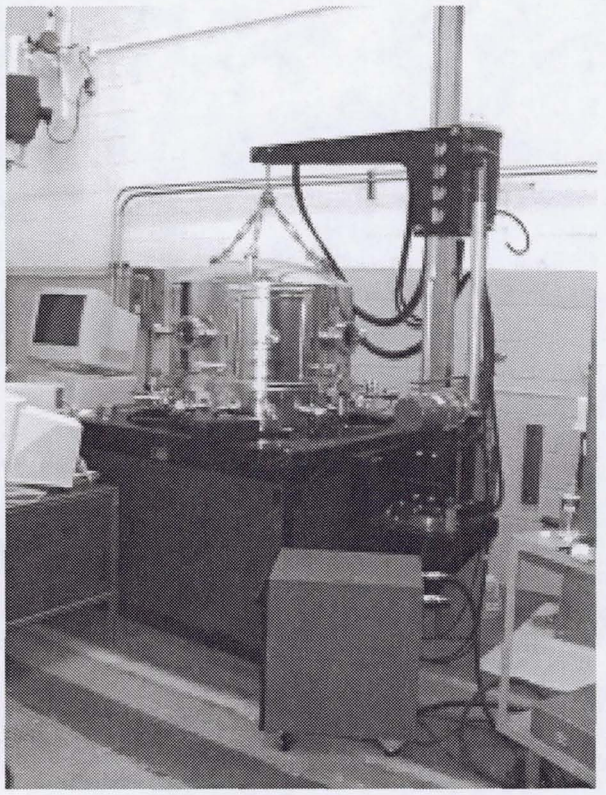
Point of Contact:

- Thermal Structures Laboratory, Building 1267. Kamran Daryabeigi (757) 864-4745 or Branch Head: Dr. Stephen J.Scotti (757) 864-5431

Thermal-Vacuum Chamber

Purpose:

- Conduct analytical and experimental research to understand the behavior of thermal insulation concepts for re-entry space vehicles subject to static and time-varying thermal loads.



Primary Capability:

- Test for thermal properties of insulation concepts subject to thermal load at various environmental pressures.

Special/Unique Capabilities:

- Environmental chamber capable of simulating re-entry aerodynamic heating conditions.
- Pressure range of 10^{-4} to 760 torr.
- Temperature range up to 1800°F.

Point of Contact:

- Thermal Structures Laboratory, Building 1267. Kamran Daryabeigi (757) 864-4745 or Branch Head: Dr. Stephen J. Scotti (757) 864-5431

Polymeric Materials Laboratory
(Bldg 1293A)

Polymeric Film Casting Equipment

Purpose:

- To fabricate thin, uniform dust-free polymeric films for characterization and application.

Primary Capabilities:

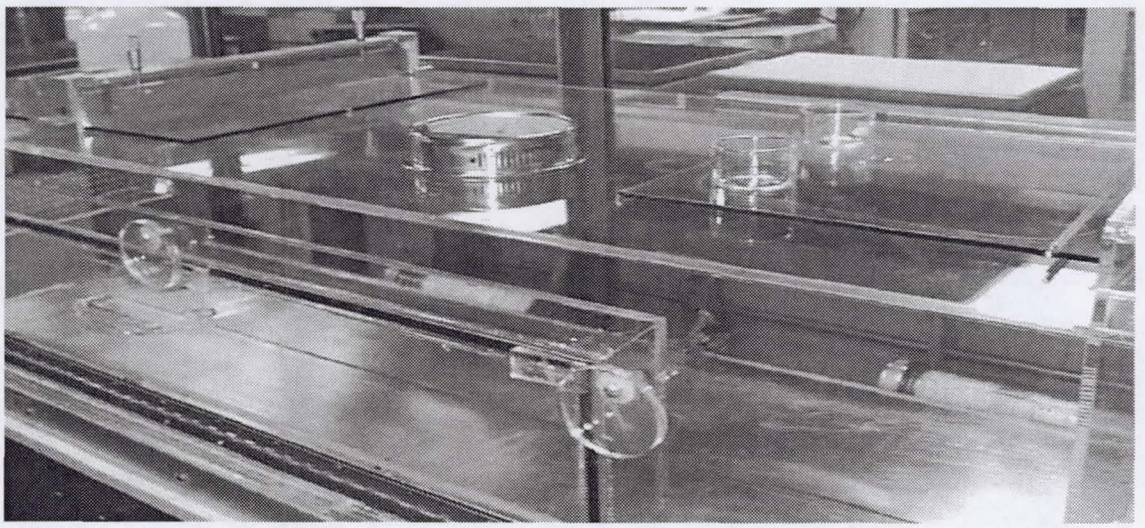
- Cast polymeric films of variable thickness onto glass plates or suitable substrates. Box dimensions (59 in. long by 16 in. wide) allow for multiple plates to be positioned. Casting box is continuously purged with dry air. Casting box is housed in a heptafiltered clean room.

Special/Unique Capability:

- Cast polymeric films onto glass using fixed doctor blade and motorized plate movement. Maximum casting size is 16 in. by 23 in.

Point of Contact:

- Polymeric Materials Laboratory, Building 1293A. Diane Stoakley (757) 864-4246 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



Polymer Film Stretcher- T. M. Long, Company

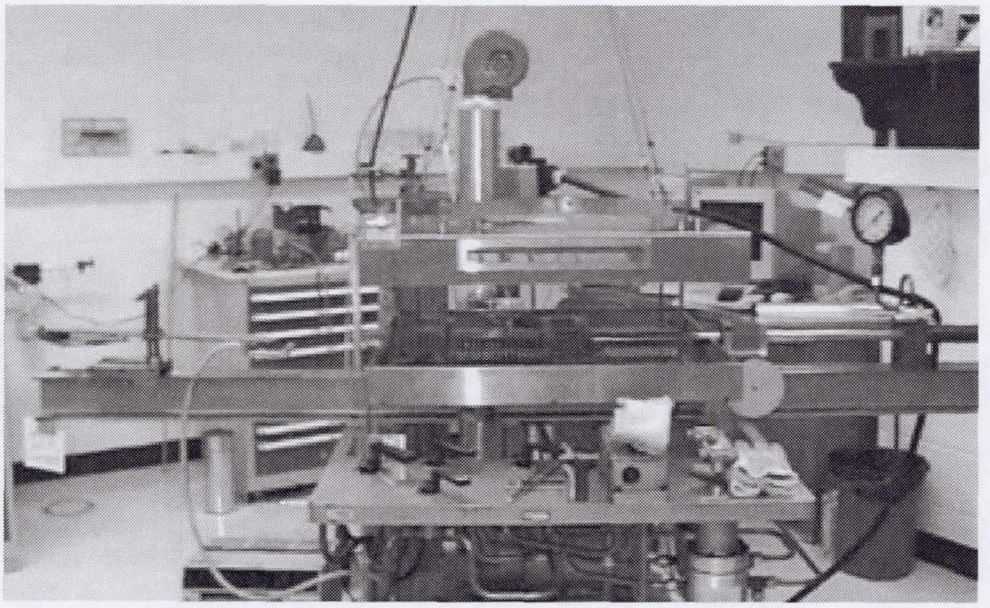
Purpose:
- Used to uniaxially and biaxially orient polymer films

Primary Capabilities:
- To enhance the mechanical properties of polymer films. Orientation can generally result in significant increases in strength and modulus.

Special/Unique Capability:
- Temperature capability to 600°F

Equipment/Instrumentation:
- Hydraulically driven stretching heads
- Hydraulic grips

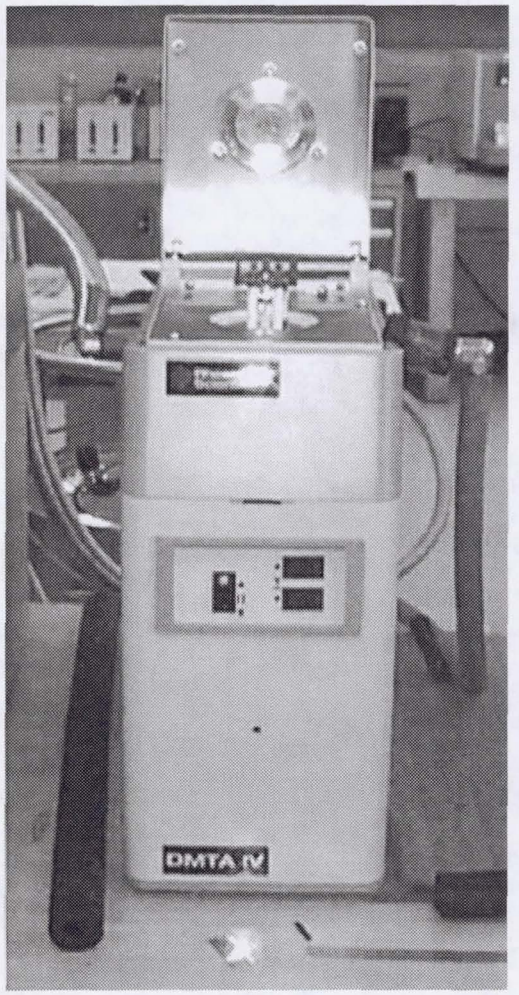
Point of Contact:
- Polymeric Materials Laboratory, Building 1293A. Dr. Jeffery Hinkley (757) 864-4259 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



Dynamic Mechanical Thermal Analyzer

Purpose:

- To experimentally determine viscoelastic properties of materials



Primary Capabilities:

- Measures E', E" and tan _ of materials.

Special/Unique Capabilities:

- Test temperatures can range from –150°C to 500°C.
- Multifrequency experiments can be conducted.
- Tests can be performed in single or double cantilever, three point bend, extension, compression and shear modes.

Equipment/Instrumentation:

- Sample forms include films, fibers, moldings and pastes.
- Frequency range: 0.01 – 100 hz
- Fully automated
- Data acquisition system: RSI Orchestrator

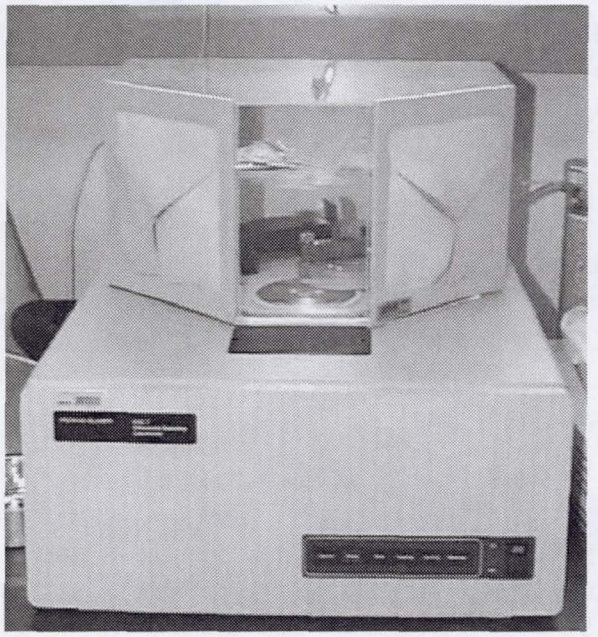
Point of Contact:

- Polymeric Materials Laboratory, Building 1293A. Dr. Mia Siochi (757) 864-4279 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Differential Scanning Calorimeter

Purpose:

- To experimentally determine thermal characteristics of various materials.



Primary Capabilities:

- Measures glass transition temperatures of polymers and composites.
- Determines melt endotherms, crystallization and cure exotherms of various materials.

Special/Unique Capabilities:

- Tests can be conducted at temperatures ranging from –150°C to 725°C.
- Programmable cooling rates
- Test atmosphere can be varied

Equipment/Instrumentation:

- Power compensated temperature null principle; measures energy directly, not as differential temperature
- Sample Type: Solids, liquids, powders, films, fibers
- Heating and Cooling Rates: 0.1°C to 200°C/min in 0.1°C increments

Point of Contact:

- Polymeric Materials Laboratory, Building 1293A. Dr. Mia Siochi (757) 864-4279 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Gel Permeation Chromatograph

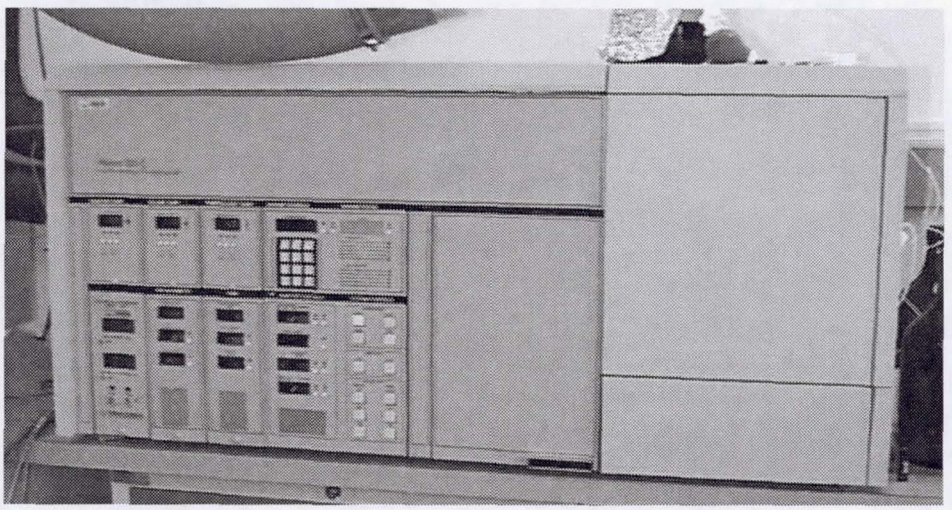
Purpose:
- To experimentally determine molecular weights and molecular weight distributions of polymers

Primary Capabilities:
- Measures number, weight and z average molecular weights of polymers
- Measures intrinsic viscosity of polymer solutions

Special/Unique Capabilities:
- Test temperatures can range from room temperature to 150°C.
- Equipped with differential viscometer and low angle laser light scattering for absolute molecular weight characterization

Equipment/Instrumentation:
- Data acquisition system (Trisec) permits triple detection GPC data acquisition.

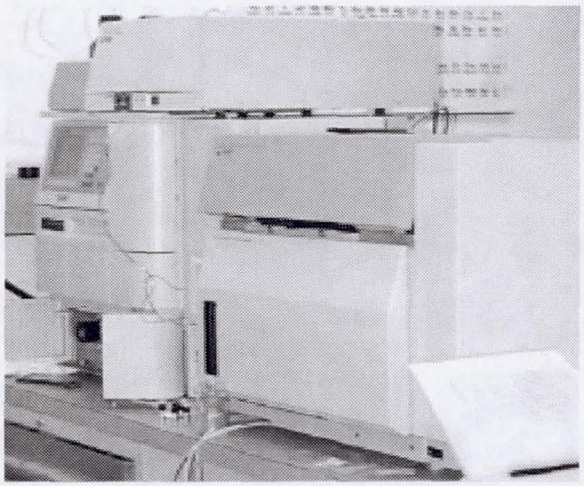
Point of Contact:
- Polymeric Materials Laboratory, Building 1293A. Dr. Mia Siochi (757) 864-4279 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



High Pressure Liquid Chromatograph/Mass Spectrometer

Purpose:

- To experimentally determine chemical composition of various materials



Primary Capabilities:

- Separates chemical components of samples and determines molecular weight of each component

Special/Unique Capability:

- Chromatograph is equipped with photodiode array detector in series with mass spectrometer.

Equipment/Instrumentation:

- Solvent delivery by two independent piston drives
- Automated degassing and blending of mobile phase components
- Electron Impact ionizer
- Mass range: 10 – 1000 m/z

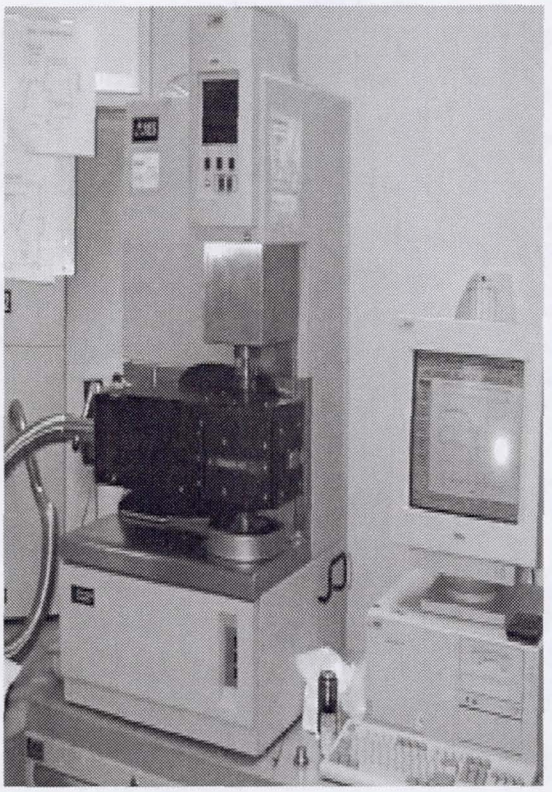
Point of Contact:

- Polymeric Materials Laboratory, Building 1293A. Dr. Mia Siochi (757) 864-4279 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Rheometer

Purpose:

- To experimentally determine viscoelastic shear properties of polymers and composites



Primary Capabilities:

- Measures shear modulus and melt viscosity of polymers in parallel plate or rectangular torsion configurations. Sample forms include powders, moldings, solutions and pastes.

Special/Unique Capabilities:

- Test temperatures can range from –150°C to 600°C.
- Multifrequency experiments can be conducted.

Equipment/Instrumentation:

- 2,000 in- lb. Load capability
- Maximum specimen size: 2" x 0.5" x 0.06"
- Frequency range: 0.1 – 100 rad/s
- Fully automated
- Data acquisition system: RSI Orchestrator

Point of Contact:

- Polymeric Materials Laboratory, Building 1293A. Dr. Tan-Hung Hou (757) 864-4251 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Thermogravimetric Analyzer

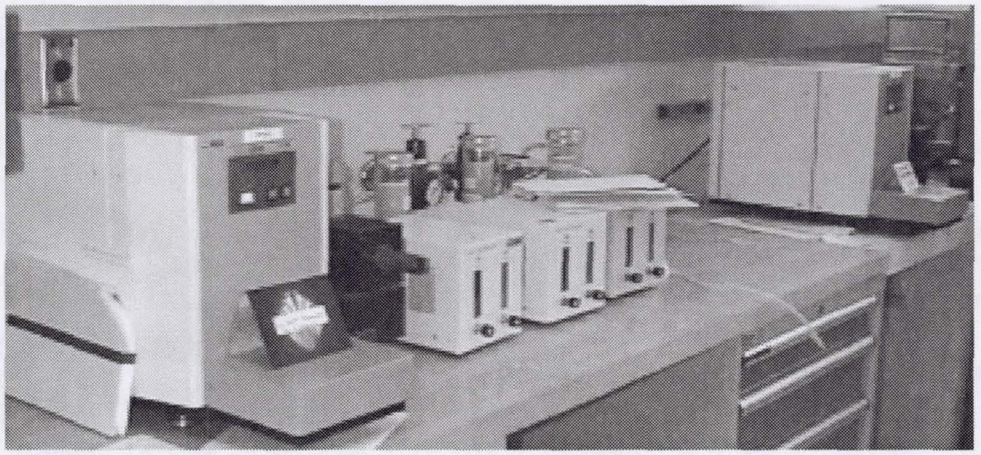
Purpose:
- To experimentally determine degradation profiles of various materials.

Primary Capabilities:
- Measures weight loss as a function of temperature and heating rate.

Special/Unique Capability:
- Test environment can be either air or nitrogen.

Equipment/Instrumentation:
- Heating range: room temperature to 1100°C
- Sample type: powders, films or moldings
- Fully automated

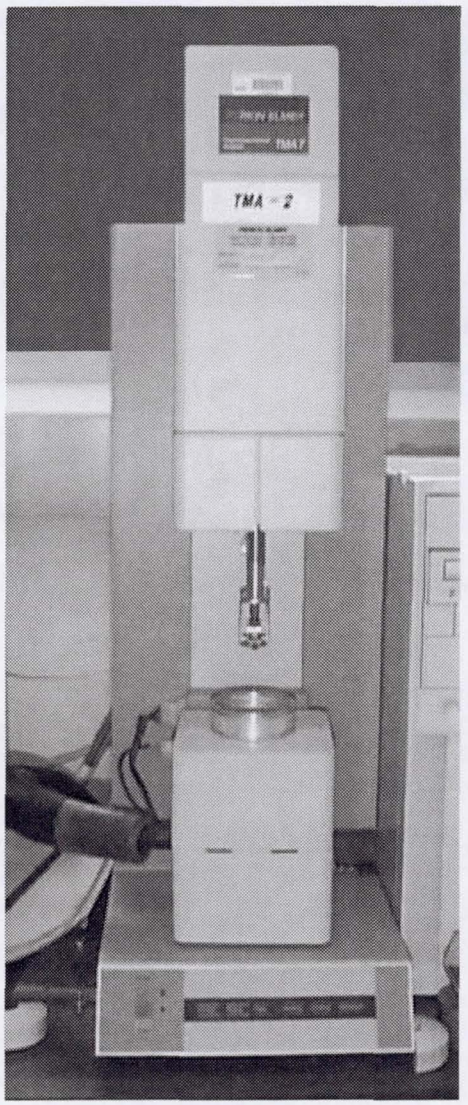
Point of Contact:
- Polymeric Materials Laboratory, Building 1293A. Dr. Mia Siochi (757) 864-4279 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



Thermomechanical Analyzer

Purpose:

- To experimentally determine coefficients of thermal expansion and softening points of various materials.



Primary Capabilities:

- Measures coefficient of thermal expansion as a function of temperature.
- Measures softening temperature of polymers and composites

Special/Unique Capabilities:

- Tests can be conducted at temperatures ranging from –150°C to 1000°C.
- Force Range: -650 to 800 g

Equipment/Instrumentation:

- Experiments can be conducted in expansion, extension, penetration, flexure, compression and dilatometer modes.
- Sample size: Up to 0.3" diameter, up to 0.75" height
- Sample Type: Solids, liquids, powders, films, fibers
- Heating and Cooling Rates: 0.1°C to 100°C/min in 0.1°C increments

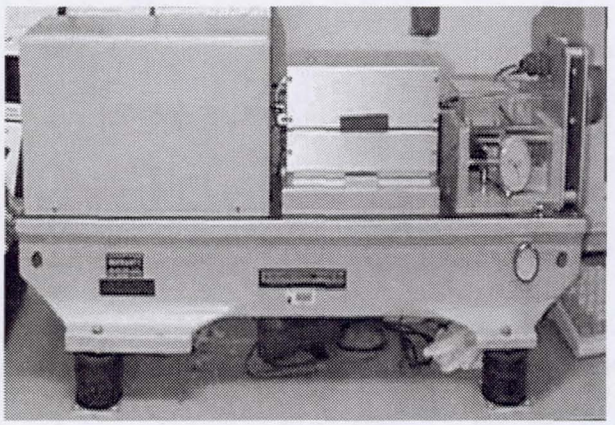
Point of Contact:

- Polymeric Materials Laboratory, Building 1293A. Dr. Mia Siochi (757) 864-4279 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Rheovibron DDV-II-C

Purpose:

- Measures mechanical properties
- (E', E", and tan _) and in-plane piezoelectric properties (d_{31} and d_{32}) of polymer films.



Primary Capabilities:

- Measures mechanical properties of materials using ASTM standards. Determines piezoelectric properties of polymer films by measuring the charge generated in response to an applied stress.

Special/Unique Capability:

- Enclosed sample chamber with temperature range from subambient temperatures to 300°C

Equipment/Instrumentation:

- Frequency range: 0.1 - 125 Hz
- Sample dimensions: 2 - 4 cm long, 0.5 cm wide, 0.02 - 0.1 mm thick
- Computer interfaced with 2 digitally recorded channels

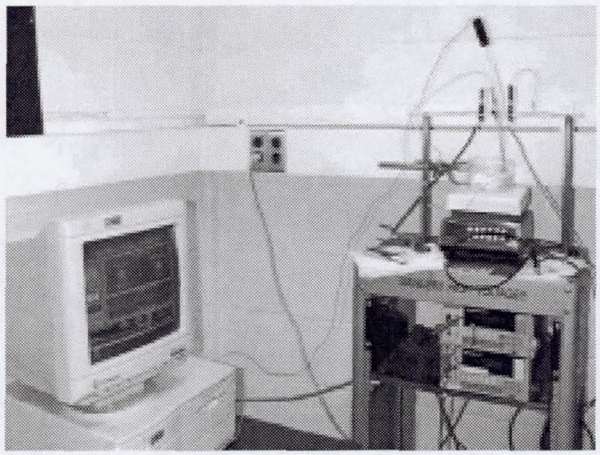
Point of Contact:

- Polymeric Materials Laboratory, Building 1293A. Dr. Joycelyn S. Harrison (757) 864-4239 or Branch Head: Dr. Terry L. St.Clair (757) 864-4273

High Voltage Poling Station

Purpose:

- Introduces a preferred orientation of molecular dipoles within a polymer, ceramic or composite material by applying an electric field.



Primary Capabilities:

- High voltage poling station was developed to introduce dipole orientation into polymers to induce a piezoelectric effect. Samples are heated to enhance molecular mobility using a hot oil bath and subsequently cooled in the presence of the electric field to freeze in orientation.

Special/Unique Capability:

- Computer interfaced using Labview programming. Two modes of operation: ac ferroelectric hysteresis and dc poling modes

Equipment/Instrumentation:

- Voltage range: ±20 kV
- Temperature range: room temperature to 230°C
- Frequency range for hysteresis measurement: 200 mHz to 8000 mHz

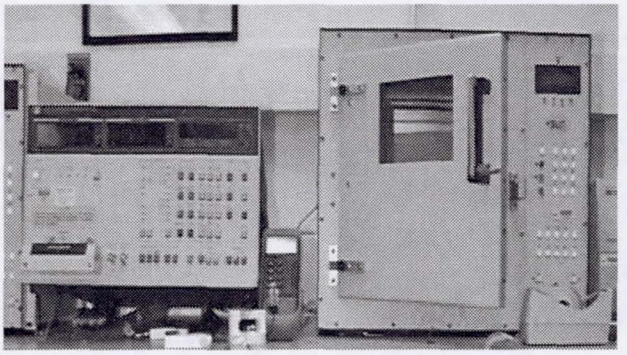
Point of Contact:

- Polymeric Materials Laboratory, Building 1293A. Dr. Joycelyn S. Harrison (757) 864-4239 or Branch Head: Dr. Terry L. St.Clair (757) 864-4273

HP 4192A Impedance Analyzer

Purpose:

- The HP 4192A impedance analyzer is used to measure electrical properties of materials.



Primary Capabilities:

- The HP 4192A impedance analyzer measures electrical impedance, phase angle, resistance, conductance, inductance, capacitance, and dissipation factor. Primary use in our lab is for characterizing dielectric properties of polymers as a function of frequency and temperature.

Special/Unique Capability:

- Computer interfaced using Labview programming for automated data acquisition. Can be used with environmental chamber shown for characterization as a function of temperature.

Equipment/Instrumentation:

- Frequency range : 5 Hz to 13 MHz
- Temperature range using environmental chamber: subambient to 315°C

Point of Contact:

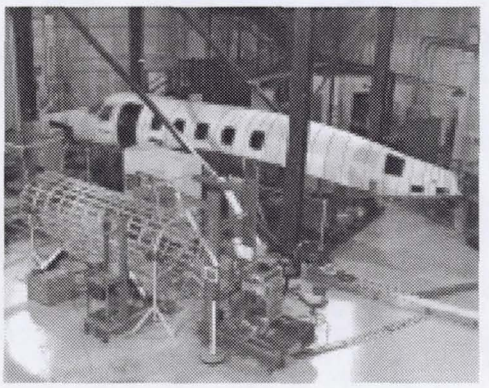
- Polymeric Materials Laboratory, Building 1293A. Dr. Joycelyn S. Harrison (757) 864-4239 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Structural Dynamics Laboratory
(Bldg 1293C)

Dynamics Testing and Research Laboratory

Purpose:

- Modal tests and active vibration control experiments. The photograph shows 2 test articles occupying approximately one-third of the available workspace.



Primary Capabilities:

- 5200 ft^2, 80-ft high, with overhead platform 73 ft above floor
- 20 x 30, 40-ft high, freestanding gantry with removable decking
- 416 channels of modern, parallel data acquisition in second floor control room
- IBM/CAMAC computer systems for active control experiments
- Temperature controlled environment

Special/Unique Capabilities:

- One of the largest data acquisition systems in the world for modal testing
- More than 400 light-weight accelerometers with modular mounting connectors and computer-controlled amplification
- Long-stroke, lightweight-armature shakers
- Ultra-low-frequency suspension devices (< 0.1 Hz), which can be located 73 ft above floor
- Arc-second attitude and jitter measurement system

Equipment/Instrumentation:

- 640 instrumentation lines running from lab floor to control room
- Ethernet jacks available throughout the facility
- Large inventory of shakers, sensors, support equipment
- Safety cut-off systems for active control experiments

Point of Contact:

- Structural Dynamics Laboratory, Building 1293A. Richard S. Pappa (757) 864-4321or Branch Head: Dr. Howard M. Adelman (757) 864-2804

Composite Materials Laboratory (Bldg 1293C)

Adhesive Hot Presses:

Purpose:

- To fabricate adhesive test coupons for testing and evaluation.

Primary Capabilities:

- To process and consolidate lap shear and flatwise tensile coupons with the application of temperature and pressure.

Special/Unique Capabilities:

- Two presses with temperature/pressure range up to 800°F and 1000 lbs.
- Two presses with temperature/pressure range up to 800°F and 200 lbs.

Equipment/Instrumentation:

- Carver Presses
  - 6" x 6" platen dimensions
  - 200 -1,000 lbs/800°F
  - Manual control

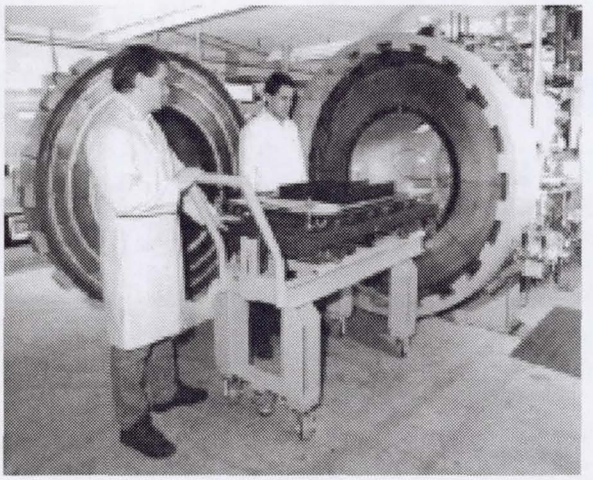
Point of Contact:

- Composite Materials Laboratory, Building 1293C. Roberto J. Cano (757) 864-3951 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Autoclaves: Thermal Equipment-United McGill

Purpose:

- To fabricate composite test panels and structural components for testing and evaluation.

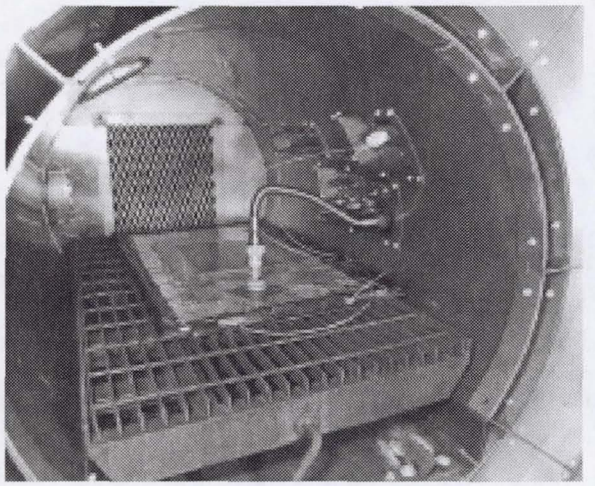


Primary Capabilities:

- To process and consolidate composite materials with the application of temperature, pressure and vacuum.

Special/Unique Capabilities:

- Temperature range up to 800°F and 400 psi.
- Dielectric process control availability



Equipment/Instrumentation:

- Thermal Equipment
  - 30" x 48" inner dimension
  - 400psi/800°F
  - Computer controlled/programmable
- United McGill
  - 12" x 48" inner dimension
  - 330psi/800°F
  - Computer controlled/programmable

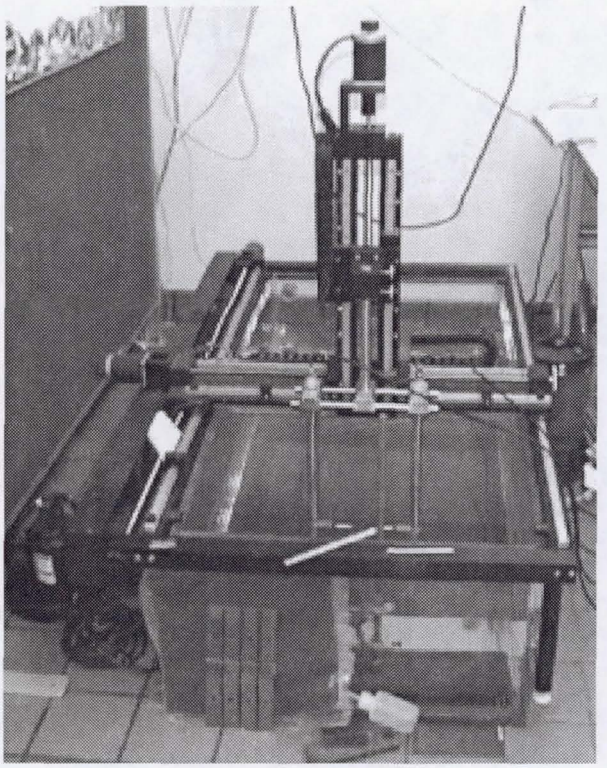
Point of Contact:

- Composite Materials Laboratory, Building 1293C. Roberto J. Cano (757) 864-3951 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Ultrasonic C-Scan Equipment - Sonix Company

Purpose:

- For semi-quantitative assessment of fiber-reinforced composite consolidation



Primary Capabilities:

- Test for composite quality as part of fabrication process development. Has capability for quantitative examination if used with standards

Special/Unique Capability:

- State of the art equipment with a 2-foot x 4-foot tank. Through transmission and pulse echo modes with on-line C-scan updates

Equipment/Instrumentation:

- Computer operated with computer generated data/figures

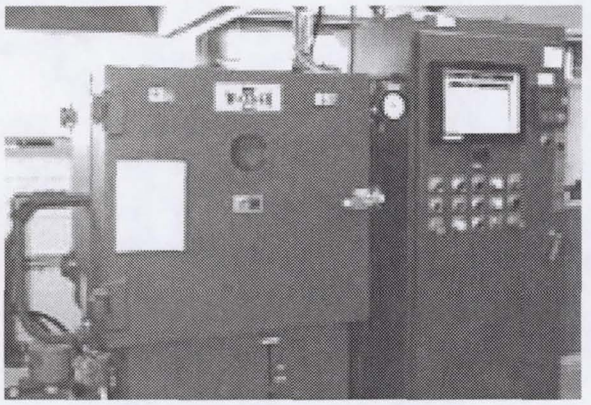
Point of Contact:

- Composite Materials Laboratory, Building 1293C. Harry Belvin (757) 864-9436 or Branch Head: Dr. Terry L. St.Clair (757) 864-4273

Vacuum Hot Presses

Purpose:

- To fabricate composite test panels and structural components for testing and evaluation.



Primary Capabilities:

- To process and consolidate composite materials with the application of temperature, pressure and vacuum.

Special/Unique Capability:

- Temperature/pressure range up to 800°F and 80,000 lbs.

Equipment/Instrumentation:

- Technical Machine Products
  - 18" x 18" platen dimensions
  - 80,000 lbs/800°F
  - Computer controlled/programmable
- Wabash
  - 18" x 18" platen dimensions
  - 80,000 lbs/800°F
  - Computer controlled/programmable
- Technical Machine Products
  - 12" x 12" platen dimensions
  - 4,000 lbs/800°F
  - Computer controlled/programmable.

Point of Contact:

- Composite Materials Laboratory, Building 1293C. Roberto J. Cano (757) 864-3951 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

AMPB Multipurpose Prepreg Machine

Purpose:

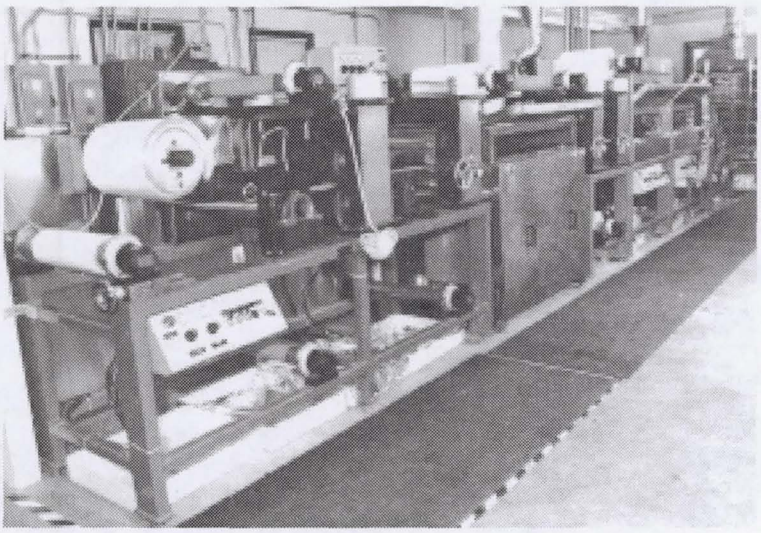
- To fabricate experimental quantities of polymer matrix prepreg.

Primary Capabilities:

- The Advanced Materials and Processing Branch's multipurpose prepreg machine has the capability of making unidirectional prepreg from any fiber/ resin combination. Prepreg tapes up to **twelve inches wide** can be manufactured from one of various prepregging techniques including:
  - **solution coating**
  - **hot melt coating**
  - **reverse roll coating**
  - **film casting**

Equipment:

- The tape machine, which is modular in design, allows for the flexibility to only use components as required for a particular application. The modular units include:



  - **fiber creel** (spool capability: 144 ends)
  - **fiber comb**
  - **reverse roll coater** (temperature capability: 400°F)
  - **solution dip pan/impregnation bar assembly** (temperature capability: 400°F)
  - **metering bar assembly**
  - four **heated nip stations** (temperature and pressure capabilities: 400°F and 45 psi)
  - two 3'-long **hot plates**(temperature capabilities: 800°F)
  - one 3'-long **forced air oven** (temperature capability: 800°F)

- **chill plate**(temperature capability: 40°F)
- **drive roller**
- **product take-up** (3" or 10" diameter)

Point of Contact:

- Composite Materials Laboratory, Building 1293C. Roberto J. Cano (757) 864-3951 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Solventless Prepreg Ribbon Fabrication Apparatus (Ribbonizer)

Purpose:

- To fabricate experimental quantities of newly developed polymer prepregs for Automated Tow Placement

Primary Capabilities:

- Manufactures a solventless unidirectional prepreg ribbon, 0.250 inch in width, for insitu processing with an ATP robot, for material evaluation. Uses powder-coated carbon fiber tow bundles as the precursor for ribbon fabrication.

Special/Unique Capability:

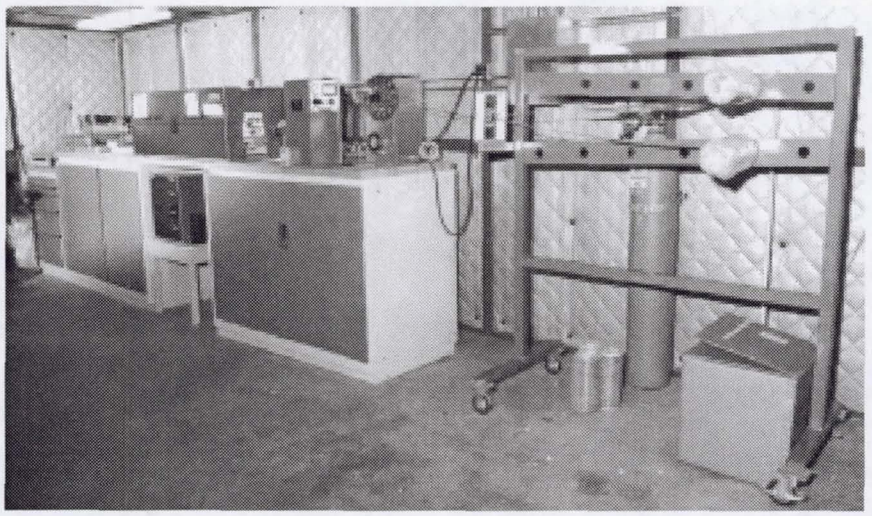
- Manufactures in excess of 1500 ft of continuous material for placement.

Equipment/Instrumentation:

- Processing component with temperature range up to 1200°C
- Individually tensioned pay-out component for precursor insertion
- Ribbonizier has speed range up to 45 ft/min
- Individually cooled ribbon forming component

Point of Contact:

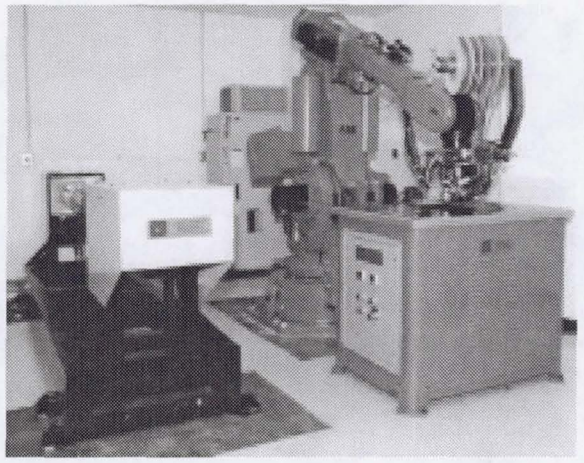
- Composite Materials Laboratory, Building 1293C. Harry L. Belvin (757) 864-9436 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273



AMPB Advanced Tape Placement Facility

Purpose:

- To perform research on out-of-autoclave processing of composite materials. Research areas include the evaluation of advanced high-temperature resins for Advanced Tow/Tape Placement (ATP) and the investigation of novel processing techniques such as infrared and electron beam heating/curing.



Primary Capabilities:

- The fiber placement machine is capable of placing 1.25 in wide composite tape at lay-down rates up to 3 in/sec.

Equipment:

- Hot gas torches capable of attaining 900°C heat the incoming tape and substrate material. A compaction roller capable of 450°C and loads of up to 300 lbs consolidate the laminate. The facility is equipped with tools that enable the fabrication of flat panels and cylindrical shells.

Point of Contact:

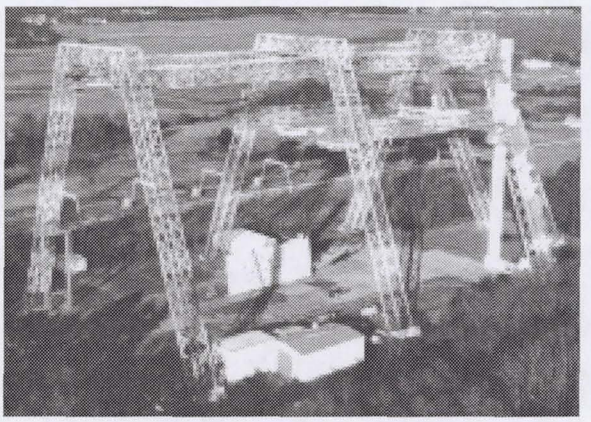
- Composite Materials Laboratory, Building 1293A. Roberto J. Cano (757) 864-3951 or Branch Head: Dr. Terry L. St. Clair (757) 864-4273

Impact Dynamics Research Facility (Bldg 1297)

Impact Dynamics Research Facility

Purpose:

- Facility to simulate crashes of full-scale aircraft, up to 30,000 lbs, under controlled conditions.



Primary Capabilities:

- Full scale aircraft controlled crash tests
- A-frame structure approx. 400 ft long by 200 ft. wide
- Various impact runway conditions
- Impact angles from 0 to 30 degrees
- Impact velocity up to approx. 65 mph
- Pitch, roll, and yaw can be varied depending on suspension harness
- On-board data transferred through umbilical cable to the supporting frame

Special/Unique Capability:

- Full-scale aircraft test up to 30,000 lbs,

Equipment/Instrumentation:

- Photographic data from on-board and ground mounted cameras
- Strain gages and accelerometer data available upon request

Point of Contact:

- Impact Dynamics Research Facility, Building 1297. Lisa E. Jones (757) 864-4148 Branch Head: Dr. Howard M. Adelman (757) 864-2804

Transonic Dynamics Tunnel Complex (Bldg 648)

Transonic Dynamics Tunnel

Purpose:

- Identify, understand, and solve relevant transonic aeroelastic problems and complex unsteady aerodynamic problems associated with fixed-wing aircraft, rotorcraft, and launch vehicles.

Primary Capabilities:

- Wind-tunnel testing to investigate: flutter, buffet, divergence, and other fixed wing transonic aeroelastic phenomena; helicopter and tiltrotor performance, loads and aeroelastic stability characteristics; launch vehicle ground-wind loads; unsteady aerodynamic flows; and active control system concepts.

Special/Unique Capabilities:

- Closed-circuit, continuous-flow, single-return, wind tunnel with 16-foot square test section.
- Use of air or a heavy gas (R-134a) as the test medium.
- Continuous Mach variation from 0.0 to 1.2; stagnation pressures continuous from near vacuum to atmospheric; maximum Reynolds numbers of 3 million/foot in air and 10 million/foot in R-134a; and maximum dynamic pressures of 330 psf in air and 550 psf in R-134a.
- Model support systems include: sidewall turntable for semispan models; variety of stings for full-span models; 2-cable suspension system for "flying" full-span models; and a floor-mounted turntable for helicopter testbed and launch vehicle models.
- Rapid tunnel shut-down capability for improved model safety following instabilities.
- Flow oscillation capability.

Equipment/Instrumentation:

- State-of-the-art dynamic data acquisition system. Signal conditioning, filtering, and sample-and-hold analog-to-digital conversion for 256 channels; data sampled at an aggregate rate of about 300,000 samples per second; distributed real-time data display capability.
- On-line frequency analysis, post-point time- and frequency-domain data analysis, and controller performance evaluations.
- Strain gages, accelerometers, potentiometers, ESP transducers, and individual insitu unsteady pressure measurement devices.
- High-pressure air, water, and hydraulics available.
- State-of-the-art ground vibration test equipment.

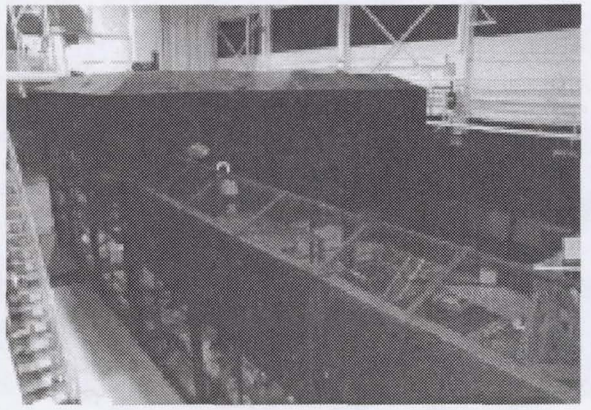
Point of Contact:

- Transonic Dynamics Tunnel Complex, Building 648. Branch Head: Dr. Thomas E. Noll, (757) 864-1207

Rotorcraft Hover Test Facility

Purpose:

- To perform experimental aeroelastic and performance studies of rotor systems in hover, and to prepare rotorcraft models for entry into the Transonic Dynamics Tunnel (TDT).



Primary Capabilities:

- Designed for testing of Froude-scaled aeroelastic rotor models. Hover testing of model rotor systems with diameters up to 10 feet.

Special/Unique Capabilities:

- One cage tailored for isolated rotor tests with elevated platform outside of ground effect.
- One cage tailored for use with tiltrotor systems including an elastic wing cantilever mount.

Equipment/Instrumentation:

- Fully integrated flexible data acquisition system capable of sampling 64 channels at over 1000 Hz.
- Closed-circuit water system with chiller to cool electric drive motors.
- Integrated hydraulic system capable of 3000 PSI and high flow rates.
- High-intensity strobe lights for rotor blade tracking.
- Color camera system with pan, tilt, and zoom for rotor system observation.
- Black and white camera system with pan & tilt designed to aid in rotor track and balance operations.

Point of Contact:

- Transonic Dynamics Tunnel Complex, Building 648. Branch Head: Dr. Thomas E. Noll (757) 864-1207

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13. ABSTRACT (Maximum 200 words)

The NASA Center of Excellent for Structures and Materials at Langley Research Center is responsible for conducting research and developing useable technology in the areas of advanced materials and processing technologies, durability, damage tolerance, structural concepts, advanced sensors, intelligent systems, aircraft ground operations, reliability, prediction tools, performance validation, aeroelastic response, and structural dynamics behavior for aerospace vehicles. Supporting the research activities is a complementary set of facilities and capabilities documented in this report. Because of the volume of information, the information collected was restricted in most cases to one page. Specific questions from potential customers or partners should be directed to the points of contacts provided with the various capabilities. Grouping of the equipment is by location as opposed to function. Geographical information of the various buildings housing the equipment is also provided. Since this is the first time that such an inventory is ever collected at Langley it is by no means complete. It is estimated that over 90 percent of the equipment capabilities at hand are included but equipment is continuously being updated and will be reported in the future.

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